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Lessons for the Global Spatial Data Infrastructure: International Case Study Analysis

*Beth E. Lachman, Anny Wong,
Debra Knopman, Kim Gavin*

Science and Technology Policy Institute

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*Beth E. Lachman, Anny Wong,
Debra Knopman, Kim Gavin*

*Prepared for the
Global Spatial Data Infrastructure (GSDI) Secretariat*

Science and Technology Policy Institute

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Preface

This report presents a RAND analysis of international collaboration for the Global Spatial Data Infrastructure (GSDI). Ten in-depth international and regional collaboration case studies were conducted to assess lessons learned for GSDI development and implementation. This report can provide useful information to the GSDI and regional Spatial Data Infrastructure (SDI) organizations. It should also be of interest to national governments, non-governmental organizations, researchers, and others who are interested in international collaboration, geospatial data sharing, and geospatial technologies.

The White House Office of Science and Technology Policy (OSTP), the Federal Geographic Data Committee, and the Global Spatial Data Infrastructure Secretariat asked RAND to conduct this analysis because of the importance of understanding evolving geospatial data-sharing activities. Funding for this study was originally provided by the Federal Geographic Data Committee, with additional support provided by the Geographical Survey Institute of Japan so that additional case studies could be conducted. This research was conducted by RAND's Science and Technology Policy Institute.

Originally created by Congress in 1991 as the Critical Technologies Institute and renamed in 1998, the Science and Technology Policy Institute is a U.S. federally funded research and development center sponsored by the National Science Foundation and managed by RAND, a non-profit organization dedicated to policy analysis and research in the public interest. The Institute's mission is to help improve public policy by conducting objective, independent research and analysis on policy issues that involve science and technology.

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Summary

Geospatial data, information, and technologies are becoming more important and more common tools throughout the world because of their capacity to improve government and private sector decision making. Geospatial information is developed, used, maintained and shared in a range of application areas, including: transportation, environment, natural resources, agriculture, telecommunications, mapping, health, emergency services, research, and national security. Sharing geospatial data in such applications helps improve the management of public infrastructures and natural resources and produces numerous other benefits.

Many nations and regions around the world are developing Spatial Data Infrastructures (SDIs) to help facilitate cooperative production, use, and sharing of geospatial information. An SDI usually encompasses policies, standards, technologies and procedures for organizations to cooperatively produce and share geographic data. The Global Spatial Data Infrastructure (GSDI) is a fairly recent international collaboration that promotes the development of SDIs throughout the world. Like other SDIs, GSDI is focusing on the development of policies and processes to enable efficient geospatial data sharing and use. GSDI is being advanced through the leadership of many nations and organizations represented by a GSDI Steering Committee, which includes representatives from all continents, and from government, academia, and the private sector. At this point, GSDI consists mostly of dedicated volunteers, modeled on national SDIs, with small amounts of funding from various governments.

This Study: Purpose and Approach

GSDI is a new organization, still in its formative stages, staffed in large part by dedicated volunteers and funded by small amounts of “seed” money from participant governments. In this early stage, GSDI faces important decisions about its future. For example, GSDI needs to decide: (1) how to develop and maintain membership participation and a solid resource base; (2) how the organization should be incorporated and operationally structured; and (3) how it should interact with other international, regional, and national entities. To help inform these decisions, RAND was commissioned to study organizations with similar attributes to understand the source of their varying degrees of success,

and help GSDI to draw on these lessons for its own development and implementation.

The study began by identifying key characteristics of GSDI and the key challenges and decisions it faces. We then conducted case studies of international collaborative organizations and other relevant entities, such as regional SDIs. All of these organizations promote global science or technology infrastructures, as GSDI does.

We conducted 10 case studies. Six involved international (global) collaborations:

- Global Map
- International Civil Aviation Organization (ICAO)
- International Council for Science (ICSU)
- International Geosphere-Biosphere Programme (IGBP)
- World Meteorological Organization (WMO)
- Intergovernmental Panel on Climate Change (IPCC).

The other four were regional SDI collaborations:

- Environmental Information Systems (EIS)-Africa
- European Umbrella Organisation for Geographic Information (EUROGI)
- Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)
- Permanent Committee on SDI for the Americas (PC IDEA).

Common Characteristics of Successful Organizations

Our in-depth case study analysis identified eight themes that appeared most relevant to the success of many of these organizations.

- In most of the case-study entities, the structure and organization evolved over time. Many of the collaborations started with an informal structure and became more formal as they grew.
- For most of them, regional approaches were important, especially for outreach, dealing with cultural and political differences, and recruiting participation in developing countries.
- Most provided aid or helped facilitate technical assistance and training, often through partnerships.

- Most had special programs or activities for developing countries. Such activities focused on finding or providing resources, including financial, educational, and technical, to help developing countries participate in the collaboration.
- Most of the organizations had diverse funding sources and were creative in their ability to leverage resources and partner to secure funds for their activities.
- Most were flexible and adapted as needed to changes, such as technical changes, like Internet communication mechanisms, and funding changes, such as a decrease in UN funding.
- In all the cases, personal relationships and communication were important among members.
- Most of the organizations also developed a network of collaborative relationships with other relevant international and regional organizations.

Recommendations

Based on a synthesis of the themes and lessons that emerged from the case study analysis, we make the following recommendations for GSDI:

1. Balance formal structure with flexibility. A formal legal structure, such as an incorporated non-profit institution with a legal charter and governance, will improve GSDI's credibility, visibility, and financial support. However, such a structure needs to include flexibility so the organization can adapt to changing conditions and still allow for innovation and creativity by individuals and nations.
2. Focus on customers and customize membership activities. Needs and interests in geospatial information throughout the world differ widely because of diverse cultural, financial, economic and legal approaches. Diverse customer professional interests, and regional and local concerns, mean customers will participate in GSDI for different reasons. For example, an environmental scientist in a developed Asian country, an economic development official in a developing African country and a mapping government official in a South American country would have different interests in geospatial information and the sharing of geospatial data. GSDI should tailor its activities to customers and accommodate their diverse needs. These activities could include developing different outreach plans and business cases for diverse geospatial application interests and prototype projects focused on customers' specific needs.

3. Regional approaches are vital. GSDI will need to work with diverse interests, needs, and cultures across the world to build a truly global GSDI. Many of these vary by region and can be addressed by focusing on different regions of the world. Therefore, GSDI should develop regional approaches and work in close collaboration with regional SDIs and assist them in their SDI development processes as needed.
4. Promote and provide technical assistance. Technical expertise and infrastructure vary widely throughout the world. In addition, geospatial technologies are rapidly evolving. Given the relatively new concept of SDI, GSDI needs to promote and provide technical assistance and outreach, especially to developing countries, to build their capacity for global participation in GSDI. Developed countries, especially those that are not familiar with SDI concepts, also can need specialized SDI related assistance, such as materials to help a country create a national SDI.
5. Find and support champions. GSDI should seek out, and attract the support of "champions"—enthusiastic, motivated, and dedicated individuals who act as catalysts and leaders in creating change, innovation, and growth within an organization. Champions are needed to help develop and grow the organization by spreading its message, supporting its activities, and helping to find financial support.
6. Develop a financial strategy. Securing and maintaining financial support and other resources to conduct the organization's mission is a key implementation issue for all organizations. Growth and financial sustainability will require GSDI to tap diverse sources of financial support, and leverage resources through partnerships and other mechanisms.
7. Develop customer-focused set of SDI/GSDI business cases. GSDI needs to develop diverse business cases—that is, economic rationales for organizations to participate in national and regional SDI activities—that would show countries and individuals the values of participation in SDI and GSDI. Target audiences vary by region, country, culture, organizational types, geospatial application and economic interests, and technical expertise and infrastructure. These differences provide varying rationale for why individuals and countries may choose to actively participate in national, regional and global SDI activities. GSDI needs to develop a range of business cases that address these diverse needs. In addition, appropriate benefits need to be developed and clearly articulated for both GSDI participation and also for regional and national SDI activities, recognizing that there will be some overlap and differences in such benefits.

8. Conduct special outreach for developing countries. Developing countries often lack the financial resources, technical skills and infrastructure to develop SDI in their own countries, or participate in GSDI. Special outreach to developing countries could help strengthen these countries' ability to participate in national, regional, and global SDI activities. Specifically, GSDI should consider assisting developing countries in their search for resources to participate in GSDI; and help them build technical capacity to be able to use, maintain, and share geospatial data.
9. Develop partnerships to leverage resources and support. Partnerships – both formal and informal – often increase visibility, participation, and credibility of the organization. GSDI should develop and create partnerships with other relevant international, regional and national organizations.
10. Promote fairness, consensus building, and diverse communication mechanisms in the GSDI development process. The GSDI organization and development process should be perceived as promoting participants' interests equally and committed to consensus-building. Having ongoing effective communication and coordination mechanisms will be critical to the success of the GSDI collaboration. Mechanisms could include workshops, conference calls, e-mail, web sites, best practice documents, procedures, and standards.

By drawing from the experience of other international collaborations and regional SDI activities, GSDI has an opportunity to grow and contribute to key global geospatial data and infrastructure activities. Even more important, GSDI can contribute to the decision making processes that bear on sustainable development, economic growth, security and safety, and other public goods.

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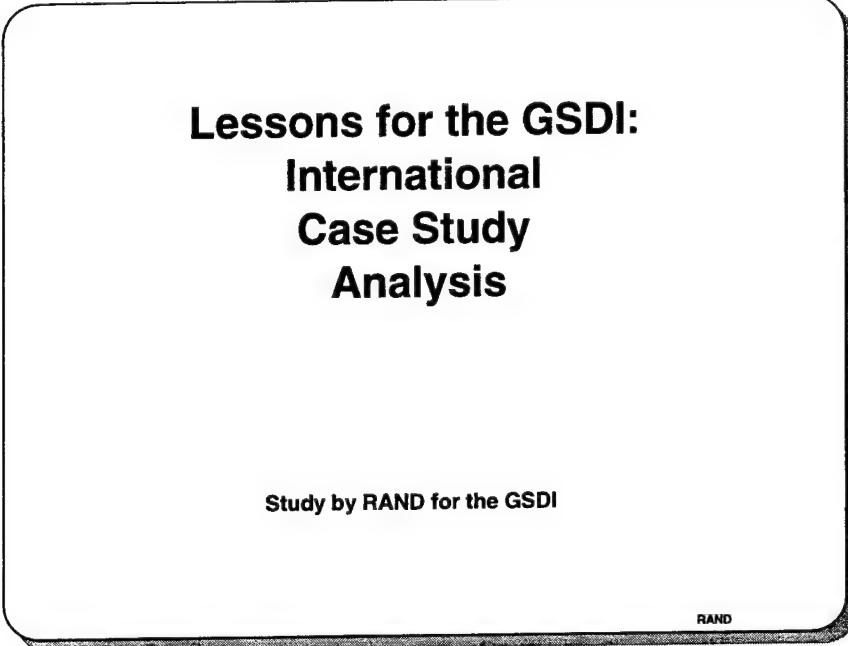
Any errors of fact and judgment are those of the authors. Views and suggestions expressed here are not necessarily those of RAND, the GSDI Secretariat, the Geographical Survey Institute of Japan, FGDC, or any of RAND's sponsors.

Acronyms

<u>Symbol</u>	<u>Definition</u>
CNS/ATM	Communications, Navigation, Surveillance/Air Traffic Management
EIS-Africa	Environmental Information Systems - Africa
EUROGI	European Umbrella Organisation for Geographic Information
FGDC	U.S. Federal Geographic Data Committee
GSDI	Global Spatial Data Infrastructure
ICAO	International Civil Aviation Organization
ICSU	International Council for Science
IGBP	International Geosphere-Biosphere Programme
IHDP	International Human Dimensions Programme
IP	Intellectual Property
IPCC	Intergovernmental Panel on Climate Change
ISCGM	International Steering Committee for Global Mapping
IT	Information technologies
NGO	Non-governmental organization
NMO	National mapping organization
NSDI	National Spatial Data Infrastructure
PC IDEA	Permanent Committee on SDI for the Americas
PCGIAP	Permanent Committee on GIS Infrastructure for Asia and the Pacific
SDI	Spatial Data Infrastructure
START	The Global Change SysTem for Analysis, Research, and Training
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization

UNFCCC	United Nations Framework Convention on Climate Change
UNRCC-Americas	United Nations Regional Cartographic Conference for the Americas
UNRCC-AP	United Nations Regional Cartographic Conference for Asia and the Pacific
WMO	World Meteorological Organization
WWW	World Wide Web

1. Introduction



Lessons for the GSDI: International Case Study Analysis

Study by RAND for the GSDI

RAND

During the spring and summer of 2001, analysts with RAND's Science and Technology Policy Institute conducted a study for the Global Spatial Data Infrastructure (GSDI) Steering Committee. The purpose of the study was to analyze a series of case studies and draw relevant lessons for GSDI's development and implementation.

This document presents the final results of this study in an annotated briefing format.

Outline

- 1. Introduction**
- 2. Brief overview of the case studies**
- 3. Lessons learned and findings for the GSDI**
- 4. Case study details**

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The briefing has four parts. This introductory section describes the study objectives and the case study methodology. The second section provides a brief overview of the case studies. This section also explains the different types of cases and summarizes differences and similarities them. The third section presents the results of the analysis, namely, the main lessons learned and recommendations to GSDI. The last section presents detailed information about the case studies. Note that sections 1 through 3 can be read as a stand-alone document, with the reader referring to section 4 as needed for detailed descriptions on individual case studies and more detailed examples of lessons for GSDI implementation.

An appendix lists all the case studies used in the analysis.

Background and Motivation

Global Spatial Data Infrastructure (GSDI) is an initiative with a role in

- **Sharing of geospatial data**
- **Geospatial market developments**
- **Supporting sustainable development**

GSDI Steering Committee is facing important decisions about

- **Membership development and participation**
- **Developing and maintaining a resource base**
- **Its evolving structure**
- **Relationship with other activities**

RAND

The Global Spatial Data Infrastructure (GSDI) is a relatively new international collaboration that promotes the development of Spatial Data Infrastructures(SDI) throughout the world. Its purpose is to foster policies and processes to enable geospatial data¹ sharing and use. The GSDI defines itself as follows:

"The Global Spatial Data Infrastructure supports ready global access to geographic information. This is achieved through the coordinated actions of nations and organizations that promote awareness and implementation of complimentary policies, common standards and effective mechanisms for the development and availability of interoperable digital geographic data and technologies to support decision making at all scales for multiple purposes. These actions encompass the policies, organizational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the global and regional scale are not impeded in meeting their objectives."²

The core goals of GSDI are to:

¹ In this document there are many terms that are used to refer to georeferenced data and information, including: spatial data, geospatial data, geo-information and geographic information. In discussing each of the different organizations, we chose to use the same terminology used by that organization.

² From the GSDI web site: <http://www.gsdi.org/> See this site for more information about GSDI.

- "Articulate the operational environment needed to achieve Global SDI compatibility
- Help build globally compatible SDI capacity around the world
- Educate decision-makers on the benefits of GSDI inside and outside their borders
- Assure that different SDI related policies can be facilitated by the GSDI
- Advance the GSDI mission until a global SDI is achieved"³

GSDI is run by a Steering Committee, consisting of representatives from many nations and organizations, and from all continents, and diverse sectors -- government, academia, and the private sector.

The GSDI collaboration could potentially have an impact on geospatial market developments, geospatial data sharing, sustainable development activities, and other emerging areas.

Still in its early phases, GSDI is facing significant decisions about directions for its development and implementation. For example, GSDI must decide how to promote membership participation and a solid resource base, how the organization should be incorporated and operationally structured, and how it should interact with other relevant international, regional, and national entities.

³ From the GSDI web site: <http://www.gsdi.org/>

Study Objective

Conduct a series of international case studies of relevant organizations

Draw lessons learned from the case studies to help in GSDI's development and implementation

RAND

RAND conducted this analysis of existing international activities to inform future GSDI development and implementation decisions. The RAND study focused on lessons from international collaboration case studies and other relevant organizations, such as regional SDIs.⁴ The case studies concentrated on organizations that are successful in promoting global science or technology infrastructures relevant to GSDI's needs.

⁴ An SDI usually encompasses policies, standards, technologies, and procedures for organizations to cooperatively produce and share geographic data.

Methodology

Identified the key

- Characteristics of GSDI
- Challenges and decisions for the GSDI

Selected appropriate case studies with

- Characteristics similar to the GSDI
- Success in focusing on issues and challenges

Analyzed the cases

- Studied relevant dimensions
- Noted differences and similarities to the GSDI

RAND

RAND analysts identified key characteristics of GSDI and the key challenges and decisions that GSDI faces. Next, the RAND team searched the international literature and consulted with various experts about successful examples of international collaboration.⁵ A list of potential case studies was assembled and then narrowed to cases that were most relevant to GSDI and had the greatest potential to provide insights for GSDI needs.

Once the cases were identified, we analyzed their operations and structure to understand the key elements of their success and their relevance to GSDI.

Based on the case studies and the literature review, we developed recommendations for GSDI development and implementation.

⁵ For examples of such literature see: Gaillard, Jacques, 1994 and 1995; Georghiou, Luke, 1998; and Wagner, C., et al 2001.

Key Characteristics of the GSDI

- International and global in scope**
- Hierarchical system**
- Virtual/flexible system using IT**
- Geospatial data central to the activity**
- Diverse organizations involved, but government currently has the lead**
- Main task is to enable and coordinate geospatial infrastructure development**

RAND

To guide selection of the case studies, RAND analysts first articulated the key characteristics of GSDI , and then sought similar organizations to study.

The study identified six main characteristics of GSDI:

- (1) GSDI is trying to involve every country in the world, both developing and developed; hence, other global organizations are most relevant.
- (2) GSDI builds on a hierarchical, decentralized organizational approach, where individual regions and countries have their own SDIs, and GSDI encourages and helps facilitate such activities and provides collaboration across them.
- (3) GSDI is designed to exploit the world wide web (WWW) and other information technologies (IT).
- (4) GSDI focuses on sharing geospatial data, and therefore organizations that similarly focus on such data would be most directly relevant.
- (5) National governments are the main leaders in GSDI-related activities, because relevant authority lies mainly with the nations, but activities are also driven by universities, non-governmental organizations (NGOs), and industry. Diversity also exists by culture, country, and level of technical sophistication. The varying degrees of technical sophistication among countries are another important consideration in GSDI development and implementation.
- (6) The main task of GSDI is enabling and coordinating geospatial infrastructure development. Ultimately, nations and regions have the actual responsibility, motivation, and resources for geospatial data development, use, and sharing. GSDI facilitates global collaboration for the effective organization, management, and use of geospatial data and related activities by addressing issues such as standards, policy, processes, resources, data, and technology.

Key Issues/Decisions for the GSDI

Evolving structure

- **Formality and independence**
- **Relationships with other international activities**

Membership development

- **Diverse legal, political, and cultural views**
- **Data policy issues**
- **Different resource capabilities among members**
- **Range of technical sophistication**
- **Involvement of developing countries**

Development and maintenance of a resource base

- **Funding for the coordination process**
- **Infrastructure for the coordination process**

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GSDI began as a relatively informal collaboration, but has now reached the stage of addressing structural issues. It could remain an informal organization, or alternatively, it could be more formal, with legal incorporation and a physical office. A combination of both styles could also be adopted. Also, with so many different international activities, it must decide what kind of relationships to have with other entities, like the U.N., and whether such relationships be formalized.

Development and maintenance of membership within GSDI are also important issues. Legal, cultural, and political views are diverse around the world. Data policies and technical skills vary widely among nations. How can an international geospatial organization engage and maintain participation of such diverse members? Financial and technical resources also affect membership development. Less wealthy nations, such as developing countries, may be unable to find resources or readily see the need for spatial development activities, especially international ones. Convincing and helping such developing countries to participate in national, regional, and global SDI activities is important to GSDI's development and implementation.

Developing and maintaining appropriate financial, technical, operational, and human resources is a struggle for many collaborative organizations. GSDI also faces such issues. Finding sustainable financial support and setting up appropriate operational infrastructure are especially important long-term issues for GSDI.

Key Dimensions Analyzed in Cases

- **Governance process**
- **Functions performed and facilitated**
- **Organizational structure**
- **Legal and cultural frameworks**
- **Technical sophistication issues**
- **Resources**
- **Other issues**
 - Main challenges and how they are addressed
 - Insights about international collaboration

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RAND analyzed key dimensions of each of the international collaboration case studies to understand each case's relevance for GSDI and to identify appropriate ideas and insights for GSDI's needs.

A starting point was to understand how the organization is governed. This includes identifying authority and responsibility, leads in the development process, and the organization's evolution.

The purpose, activities, and accomplishments of the organization and their relevance to GSDI were also important. We examined functions facilitated by the organization, and their similarity to GSDI's. For example, an organization implementing a fully operational infrastructure differs from GSDI performing an enabling function.

We also examined organizational structures. Questions explored here included: How is the organization structured to conduct its activities? Is it hierarchical in nature? How long has the organization been in existence and has its structure changed over time? How are the member countries or entities involved in the organization?

The organization's recognition and accommodation of the legal and cultural frameworks of different countries was another dimension analyzed. An important question here was how an organization facilitates the involvement of different countries, especially poorer developing nations.

A related point is the means by which an organization deals with differences in technical sophistication among customers and members and differences in their ability to pay for various technologies.

Understanding how an organization finds, obtains, and maintains resources is yet another important dimension. Resources are defined as financial, infrastructure, human, and technical assets needed to operate and maintain the organization. We were particularly interested in how an organization addressed the difficulty of developing countries who cannot afford to contribute to the organization.

We also asked other questions relevant for GSDI development. We were interested in identifying for each organization: its main successes; key factors that helped facilitate its success; primary strengths; benefits produced; the main challenges; and the means of overcoming the challenges. Finally, we asked representatives of each organization to identify lessons learned from their international collaboration experience that might be applicable to others.

2. Brief Overview of the Case Studies

Case Study Criteria

Main in-depth international case studies

- Successful long term examples of global collaboration in supporting science and technology development
- Parts of the organization are similar to GSDI

Regional Spatial Data Infrastructure (SDI) case studies

- Not in existence as long
- Help identify needs and appropriateness of the lessons learned from other cases

Some additional case studies to add insights, although not as similar to GSDI

RAND

The study focused on two main types of cases: international collaborations and regional SDI cases.

The international cases chosen are successful examples of global collaboration in supporting science and technology development with relevance to geospatial technologies and information. These cases also have specific characteristics that are similar to the key characteristics identified for GSDI. We also chose organizations that had a long operational history, and thereby, demonstrated success over time and had more operational experience.

Although regional SDI organizations have not existed for very long, they offer useful insights on regional activities that will likely be an integral part of GSDI's future. Most of the regional SDI organizations and GSDI will likely work closely together to promote SDI activities. The regional activities also help identify the specific needs for GSDI's development, and appropriateness of the lessons learned from the international case studies.

Some additional case studies were also analyzed, though in less depth. These cases were less relevant to GSDI needs, but they did provide additional insights

for the study and further evidence to support our findings and recommendations.

Main International Case Studies

- **Global Map**
- **International Civil Aviation Organization (ICAO)**
- **International Council for Science (ICSU)**
- **International Geosphere-Biosphere Programme (IGBP)**
- **World Meteorological Organization (WMO)**
- **Intergovernmental Panel on Climate Change (IPCC)**

RAND

The analysis focused on six main international collaboration case studies. Most of these organizations have long histories and have demonstrated success in meeting their stated objectives. They also all had similar characteristics to GSDI, including being global, having a hierarchical system, involving geospatial information, diverse organizational involvement, and a coordination function related to a science or technology infrastructure development. The cases obviously were not identical, but were chosen because they were more relevant for GSDI. For example, in some organizations, governments are taking the lead while in others, the lead is primarily academic. Both were considered relevant even though GSDI is currently led by governments, because GSDI would like to involve more leaders from other types of organizations, evolve over time, and has strong participation by academics. These international collaborations also have all dealt with the key issues of concern, such as how to involve developing countries and how to develop and maintain a resource base.

Section four describes, in detail, each of these international cases and the main lessons learned from each of them.

Regional SDI Case Studies

- **Environmental Information Systems (EIS)-Africa**
- **European Umbrella Organisation for Geographic Information (EUROGI)**
- **Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)**
- **Permanent Committee on SDI for the Americas (PC IDEA)**

RAND

The study also looked at four regional SDI-related organizations, which together cover most of the globe. Some regions, such as Europe, have more than one regional organization related to the development of spatial data. Our study examined in-depth one case per region. Each of the regional cases was chosen because it most closely resembled GSDI, or was the most active, longest-lived, or successful geospatial infrastructure development activity for the given region. In addition, these regional organizations are establishing or have already established relationships with GSDI, and are therefore, not independent of GSDI as the international ones are.

Additional SDI Case Studies

- **Organizations not as directly similar to the GSDI**
 - Provide additional insights for GSDI
 - Briefly described in the appendix
- **National SDIs**
 - About 30 examples
- **Other examples of international and regional collaboration**

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Some additional case studies were conducted in less depth. The additional organizations we examined do not closely resemble GSDI, but they provided some relevant insights. For example, the Southern African Development Community's (SADC) Environmental Information Systems Technical Unit (SETU) was originally explored as an African case study, but since it has been moved to the Regional Remote Sensing Unit of SADC and is no longer very active, we decided to focus on EIS-Africa instead. Some of the cases also helped to identify specific concerns for GSDI's development, and appropriateness of the lessons learned from the international case studies.⁶

Such cases are mostly from the literature review and they are included in the appendix.

⁶ For a good overview of national SDI's and some of the issues they face that are relevant for GSDI see: Onsrud, Harlan J., "A Global Survey of National Spatial Data Infrastructure Activities," University of Maine, Orono, Maine, undated. See <http://www.spatial.maine.edu/~onsrud/GSDI.htm> for more information about this survey.

Analysis of the Cases

The analysis process involved

- Reviewing the literature and web sites
- Phone and e-mail interviews of experts

Identified

- Differences among cases
- Common themes and trends
- Insights for GSDI

Other relevant literature was used in the analysis process

RAND

Analyzing the cases involved several steps. RAND reviewed the relevant international collaboration and spatial data literature. We also reviewed the case study organizations' web sites and key documents. International collaboration experts and members of the organizations were interviewed. Most of these interviews were phone interviews lasting from 20 minutes to over an hour. A few of the interviews were in person or conducted by e-mail. At least one person was interviewed for each of the 10 main case studies, though two or three people were interviewed per case for most of these cases.

The RAND analysis identified important differences among the cases and some common themes and trends. These were used to understand the variability and applicability of the cases. The cases were also used to identify lessons learned and suggestions for GSDI development and implementation. Obviously, our small set is not a statistically significant sample of such international collaborations. Given the uniqueness of such organizations and GSDI, it would be impossible to find such a sample. Therefore, the readers should be careful in how they use the results and we have taken care in our interpretation of these results and have supplemented them with other research information. Namely, other relevant literature was also part of the analysis that led to the final results. For example, international collaboration and organizational change literature was used in the analysis.

Summary Across Cases : Differences

Range of organizational structures

- Very formal to more informal

Organizational focus

- Technology implementation to science coordination

Customers and main participants

- Governments to academics

RAND

Our case study organizations differed in some areas worth noting. First, they had a range of different organizational structures. Some were informal, such as EIS-Africa, while others were more formal, such as WMO. The focus of the organizations also varied. Some, such as ICAO, emphasized collaboration related to technology implementation issues, while others, such as ICSU, emphasized scientific collaboration. Types of participants and clients also differed. For example, IPCC's participants are mostly individual university researchers, while Global Map participants are mostly national mapping organizations and Global Map products are available to anyone for public purposes.

Summary Across Cases : Common Themes and Trends

- **Structure and organization evolved over time**
- **Importance of regional approaches**
- **Technical assistance and partnering**
- **Special programs for developing countries**
- **Diversity and creativity in funding**
- **Flexibility and adaptability**
- **Importance of personal relationships and communication**
- **Network of relationships with other international organizations**

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In examining the case studies, especially the main international ones, we found about eight themes. For most of the cases, the structure and organization itself evolved over time. Many of the collaborations started with an informal structure and became more formal over time as they grew. For most of them regional approaches were important, especially for dealing with cultural, social, economic, and political differences, and in outreach and recruiting participation in developing countries. Most provided aid or helped facilitate technical assistance and training, often through partnerships. Most had special programs or activities for developing countries. Such activities focused on finding or providing resources, including financial, educational, and technical, to help developing countries participate in the collaboration.

Most of the organizations had diverse funding sources and were creative in their ability to leverage resources and partner to secure funds for their activities. Most were flexible and adapted as needed to changes, such as technical changes, like Internet communication mechanisms, and funding changes, such as a decrease in UN funding. In all the cases, personal relationships and communication were important among members. Most of the organizations also developed a network of collaborative relationships with other relevant international and regional organizations.

3. Lessons Learned and Findings for the GSDI

Lessons from Cases for GSDI

- Balance formal structure with flexibility**
- Customize membership development**
- Use regional approaches**
- Promote and provide technical assistance**
- Find and encourage champions**
- Develop creative sources of funds and leverage resources**
- Develop diverse business cases (economic rationale) for participation**
- Conduct special outreach for developing countries**

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In this section we summarize the main lessons learned and recommendations for GSDI from our case study analysis. These results can be grouped into the eight main points above. A detailed discussion on each point follows. Then this section describes a few other lessons learned for GSDI and some concluding remarks.

Balance Formal Structure With Flexibility

Well defined organized structure and relationships helps

- GSDI increase its credibility, networking, and visibility
- When GSDI is seeking funding
- GSDI accommodate diverse legal, political and cultural frameworks
- Countries find support for GSDI participation

Includes defining relationships with other international and regional organizations

- Building alliances and network of relationships with established organizations
- Formal agreements with UN and other organizations

Need to allow and encourage flexibility

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Based on our case analysis, we recommend that GSDI develop a legal formal structure, but such a structure needs to be sufficiently flexible to allow the organization to adapt over time and also allow for innovation and creativity. GSDI should become a legally incorporated, not-for-profit organization with a clear and well-defined mission, focus, objectives, charter, membership categories, and what the specific responsibilities are of different parts of the organization. Developing official and clearly defined relationships with other international and regional organizations is an important part of this process, especially describing GSDI's unique role and what synergies it has with similar organizations. With so many different international activities that relate to geospatial information and technologies, it is important that GSDI explains its unique role so everyone can understand how this activity relates to similar ones and the benefits and strengths that result from a well established GSDI. All supporting documents about the organization could be posted on the GSDI web site, including a well-defined purpose statement for the organization and an explanation of how it relates to similar organizations and activities, such as Global Map, Digital Earth, and regional SDIs.

Such clear statements and legal documents are needed to address different legal, political, and cultural frameworks, and to provide the organization with a clarity of purpose and legal framework. Such a formal and clearly defined structure and relationships with other organizations also helps increase the credibility and

visibility, and the networking, alliance building and funding opportunities for the organization.

A formal structure does not necessarily mean a duplication of the UN, or formal association to the UN, like ICAO, WMO and PCGIAP have. Given the UN's highly structured organization and procedural requirements, GSDI may not want to be an official UN organization, or even have as formal as structure as the UN, but it should at least have cooperative agreements with the UN. Such agreements are also needed with other relevant organizations, especially regional SDI activities. ICSU and IGBP's organizational structures and well-defined networks of relationships with other organizations are probably better examples for GSDI to use as models.

A formal structure can increase staff and time costs because of the effort required to develop relationships and the official legal documents and agreements. However, it is extremely important for credibility in the international arena. For example, it is easier for a country government employee to find support to travel to a GSDI meeting when he or she can explain GSDI's official relationship to an important international organization, like the UN, as members of PCGIAP have found. Similarly, Global Map found that having the UN issue the official invitation letter to national mapping organizations helped increase national participation in Global Map.

The structure that GSDI develops must allow flexibility, especially in how regions and nations participate, to allow for creativity and innovative ideas and activities. Specifically, the organization's structure needs to include flexibility to balance top-down collaboration through a formal structure and bottom-up collaboration by motivated individuals, such as what IPCC has. IPCC's success relies on both top-down and bottom-up scientific collaborations to help define problems and assess results. Given the diversity in regional and national interests, needs, and activities in developing SDIs, GSDI needs such flexibility. In fact, GSDI should encourage flexibility to help engage enthusiastic innovators in its activities. Such flexibility is also needed to respond and adapt to changes over time. The international collaborations that have been in existence for a very long time, four or five decades, such as WMO and ICAO, have all adapted to changing circumstances and have the flexibility (even though these organizations have formal structures) to respond to changing technologies, organizational needs, and even funding sources. Changes will happen, and GSDI needs to be able to adapt.

Customize Membership Development

Motivation to convince countries to participate in GSDI will differ by region and country

- Different cultural, financial and legal approaches
- Diverse needs/interests in geospatial data

One size does not fit all

Need general templates that are customized and adapted for different regions/customers

- Outreach and technical assistance
- Harmonization of standards
- Development of business cases (economic rationale)

Focus on specific practical projects

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The quality management literature and good business practices emphasize the centrality of the customer – knowing customer needs and trying to meet them. GSDI needs to focus on its customers and to customize membership activities for different regional, national, and individual needs. Given different cultural, financial, and legal approaches and the diverse economic, technical, and scientific needs and interests in geospatial information throughout the world, one size does not fit all. Different customer types in different locations will participate in GSDI for different reasons.

To convince individuals and organizations to actively participate in GSDI, diverse strategies are needed, as illustrated by the different motivators that the case study organizations employed, which included benefiting from the networking and learning opportunities, providing recognition, providing some technical assistance and travel benefits, and feeling the organization is an internationally important and worthwhile organization to participate in. For instance, to motivate participation, EUROGI stresses the benefits of joining this organization, which include direct involvement with the European Commission; a forum to learn and network with other experts; a knowledge center for geographic information at the European level; and the ability to participate in EUROGI projects. Such motivational activities often are simple, such as regional workshops or peer recognition. For instance, publishing participants' conference papers in a formal book provided recognition that motivated people's participation in ICSU activities.

GSDI needs to think about customizing its activities for its diverse membership, not just to improve membership participation, but also to help develop the cooperation needed to achieve its goals. General templates could be developed and adapted and customized for different regional and customer needs in areas such as training, outreach, standards and showing the economic rational of SDI development. Almost all the cases employed such an approach in one way or another either directly or indirectly, especially for developing country needs (which will be discussed more later). For example, ICAO initially tried to take a global approach to training related to air traffic control and soon realized it is more effective to have regional centers and customize training for regions. The training had to conform to general standards, but customized for local needs, expertise, procedures and technologies. Similarly, ICAO develops minimal standards for air traffic operations and allows individual countries to implement higher standards as long as such standards work with the ICAO standards. Such a harmonization strategy allows regions to adapt for their own needs, yet still be able to integrate their data and information within the global system. EIS-Africa works for the harmonization of geospatial data sets. WMO focuses on members needs and has global programs that are adapted to specific customer needs, such as the Technical Cooperation Programme, which tries to bridge the gap between developed and developing countries by the systematic transfer of meteorological and hydrological knowledge and information.

One of the most important ways to engage active participants in the organization and to show the value of SDI activities at the national, regional, and global levels is to focus on some specific geospatial projects that respond to customers local and regional needs. Specific projects that focus on useful applications of geographic information help make the benefits of SDI activities more concrete and real to participants, especially when they deal with economic or public policy areas that members care about. Global Map, IGBP's START, EUROGI, EIS-Africa, PC IDEA and PCGIAP all found such a strategy was important, especially for developing countries. For instance, PCGIAP found that specific projects, such as its data framework development and administrative boundaries project help convince members of the benefits of participation in the organization. The future of EIS-AFRICA seems to be in individuals who through their own direct project experience come to realize the value of harmonizing data sets for development, increasing data accessibility, and developing a network of technical expertise. At least for Africa, as appealing as the concept of GSDI might be in the abstract, it is unlikely to catch on unless grassroots practitioners clearly see its value in their own project experience. These are the individuals who would then go to their supervisors, and then up through the bureaucratic chain,

to get institutional support and funding. The value of GSDI must be made apparent through highly concrete field applications.

Use Regional Approaches

GSDI could develop regional strategy

- Work in close collaboration with regional SDIs
- Help facilitate the development of regional SDIs where needed

GSDI has many feasible options for developing regional approaches and activities

- Establish a regional support work group
- Create official points of contact for GSDI regions
- Develop materials for individual regions
- Have regular regional conferences and workshops
- Create regional structure under the Communication and Awareness Working Group

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Regional approaches are critical to working with the diverse interests, needs, and cultures of nations and organizations across the world. GSDI could develop a regional strategy to work in close collaboration with regional SDIs and assist them in their SDI development processes as needed. GSDI should build on what the regional SDI's have accomplished and are working to achieve. Regional SDIs understand their own member countries and regional needs better than GSDI could. GSDI should assist regional SDI's in their activities and help facilitate the development of strong and sustainable regional SDI's where GSDI help is wanted and needed.

The six main international cases had some sort of regional approach to engage more countries, especially the developing ones, in their activities. Some approaches were highly structured and formal, with dedicated offices, while others were more informal, based on regional collaborations with existing organizations. WMO has a Regional Programme to work with regional associations while ICAO created formal regional centers. IGBP created a separate non-profit organization, START, to develop regional networks of collaboration for global change research. IPCC encourages regional cooperation in greenhouse emissions inventory development to increase the relevance of the information to its providers. IPCC and Global Map have developed partnerships with key regional organizations, such as Global Map working with PCGIAP, PC IDEA, and EuroGeographics. Even regional SDI's recognize the importance and need to work at a sub-regional level, such as PCGIAP having sub-regional

workshops and collaboration for areas such as the Pacific Group and West Asia, and PC IDEA developing sub-regional groups in the Americas.

With or without a formal regional strategy, GSDI should develop some regional approaches. Based on the mechanisms used successfully in different cases, we briefly suggest some possible options for GSDI. Some of these options are more feasible in the near term than others because of financial considerations, but GSDI in its strategic planning may want to consider the possibility of working towards some of the longer term options in the future. GSDI could establish regional support networks, like IGBP START does or more formal regional centers and offices like ICAO. GSDI could develop official GSDI regions, create an official point of contact or facilitator for each and provide customized materials for each. Such official points of contact for regions and even individual countries could also be posted on the web site. Facilitators would work directly in the regions. Providing training and educational materials about SDI development and benefits information would be very useful for different regions of the world. Having ongoing regional conferences and workshops that are sponsored or co-sponsored by GSDI is another effective mechanism to engage current and new participants. Organizationally GSDI could create a regional structure under its Communication and Awareness Working Group to make sure regional needs and interests are met, and that appropriate communication mechanisms are employed. Regardless of which regional mechanisms GSDI chooses to employ, it is important that the organization conducts such activities in collaboration with the regional SDIs to benefit from their work and vice versa.

Promote and Provide Technical Assistance

SDI requires significant technical outreach

- Both physical infrastructure and human expertise
- Basic IT knowledge not always present

Many options to facilitate technical assistance

- Fellowships and technical exchange programs
- Technical cooperation committee
- Travel funds for training
- Technical cooperation missions
- Regional conferences
- Establishment of regional training centers
- Partnerships and mentors

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Given the diverse technical expertise and infrastructure throughout the world, the needs of developing countries, the rapidly evolving geospatial technologies, and the relatively new concept of SDI, GSDI needs to promote and provide technical assistance and outreach to build the capacity needed for global participation in GSDI. All ten of the organizations studied provided some sort of technical assistance, especially for developing country needs. Capacity building activities are critical and involve both physical infrastructure, such as computers and software, and technical training and education, such as how to process and manage geospatial data. Basic information technology (IT) training and education can be an important need, especially in developing countries. One cannot assume that people know how to use basic IT systems just because they send e-mail.

GSDI should be creative and flexible when providing technical assistance; there are numerous ways to promote and provide technical assistance. We will briefly highlight some of the many different mechanisms that GSDI could employ and will illustrate with examples from the case studies. GSDI could help find resources and establish fellowship and technical exchange programs, such as IGBP START's Fellowship/Visiting Scientist and Guest Lecturer Programs. Organizations with a large financial base, such as ICAO and WMO, actually establish regional training centers and offices to help provide the needed assistance. Providing travel funds for training and training materials are examples of lower cost ways to facilitate technical assistance. For instance, IPCC

provides travel support so that authors and officials from developing countries can attend IPCC workshops and meetings. EIS-Africa is working to provide basic geospatial training materials to African countries. Most of the organizations examined also provide educational related regional conferences, classes, or workshops at the local level to make the needed training more accessible to those who need it, such as IGBP START helping sponsor a GIS and remote sensing training and educational workshop in Mozambique in July 2000. Similarly, for Global Map development, the Japan International Cooperation Agency conducts some training courses in Global Mapping techniques, which helps build technical capacity. Concentrating on information dissemination can help with capacity-building, as EUROGI has found.

The establishment of a technical cooperation committee or program could help GSDI focus more on technical assistance. WMO has a technical cooperation program to help transfer meteorological and hydrological information and to help members acquire needed equipment. Similarly, ICSU has a Committee on Science and Technology in Developing Countries that helps find needed technical assistance for developing countries.

Developed and developing countries that are unfamiliar with SDI concepts, such as the role of geospatial data standards, can also benefit from specialized SDI related assistance. For example, providing basic information about SDI development can help build capacity, such as PCCIAP experienced with the "The SDI Cookbook" being a useful resource for countries that needed knowledge about the process of setting up an SDI.

GSDI does not necessarily need to conduct direct assistance itself. Many of the organizations examined tried to develop support through regions and get outside funding for technical assistance activities, including industry support. For example, WMO matches donors with countries and ICAO has found industry experts willing to donate their time to assistance missions in developing countries and found funding for their travel. In addition, GSDI should partner with other international organizations that also have an interest in basic geospatial training in developing countries. For example, IGBP has helped find funds for GIS training because it is needed for scientists to access and analyze land cover datasets. GSDI could partner with IGBP in such activities. Similarly, GIS companies have potential market reasons to help with such training and can

⁷ This document is an SDI implementation guide to assist organizations in developing SDIs. See: Nebert, Douglas D., editor, "Developing Spatial Data Infrastructures: The SDI Cookbook," Version 1.0, GSDI, July 6, 2000.

help partner in GSDI, for example, ESRI has just launched a Global Map/GSDI Grant Program.

Find and Encourage Champions

Champions are an organization's best advocate

- Enthusiastic, motivated, and dedicated
- Help spread message of the organization

Organizational change literature and cases show the importance of supporting champions for

- Providing outreach, education, and training
- Motivating new and continued participation
- Helping acquire resources
- Even providing peer pressure

Personal relationships extremely important in such activities

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The organizational and management literature contains much information about the importance of champions and change agents.⁸ Champions are the enthusiastic, motivated, and dedicated individuals who act as catalysts and leaders in creating change, innovation, and growth within an organization. Many of the organizations we examined employed dedicated champions to disseminate information about the value of the organization, motivate active participation in the organization's activities, and find resources and support for the organization. For all these reasons, and more, GSDI should seek out, encourage, and support such champions in the development of GSDI, as well as regional and national SDI activities.

Strong champions and good relationships between an organization's active members contribute significantly to the evolution and success of such organizations, especially near the beginning as the organization is promoting change and selling people on the new concepts. The case study organizations that have been around for a decade or more had such champions helping to develop and build their organizations, and many continue to rely on them. For instance, IPCC has found that the enthusiasm, motivation, and dedication of individual scientists has been a critical factor throughout the life of its organization and the organization is dependent on such champions. Similarly,

⁸ For examples from the literature, see Champy, James, 1996; Kaplan, Robert S., and David P. Norton, 2000; and Kotter, John P., 1996.

many of the regional SDI's leadership recognize the key role that champions are playing in developing their organizations. For example, EIS-Africa has learned that building the support for SDI concepts and development comes from the dedication, enthusiasm, and hard work of visionary and dedicated champions.

Another reason why champions are so important to organizations is to help motivate people to contribute voluntary time, which is critical when the organization does not yet have much financial support, as with GSDI and many SDI activities throughout the world. Personal relationships are an extremely important part of champions work, and to help motivate voluntary contributions to the organization. For example, ICSU benefits significantly from the thousands of scientist volunteers, many of whom are the best champions for ICSU activities, and who are involved because of other individual champions' personal networking.

Finding and developing a well-networked and dedicated group of champions is crucial for GSDI development, as it is for regional SDI development. For instance, PC IDEA's champions are key for implementing PC IDEA activities, and PCGIAP has learned that finding the right enthusiastic and dedicated individual within a country can significantly contribute to the country's active involvement in PCGIAP activities.

Since champions are innovators and promote new ideas and change they often cannot function very well in highly centralized and strictly structured organizations. In its organization development process, GSDI needs to ensure enough decentralization and flexibility within the organization to be able foster individual champions and enable them to operate.

Develop Creative Sources of Funds and Leverage Resources

Resource base important issue for all cases

- Stable funding for core operations
- Creativity and flexibility in finding funds for special activities, especially assisting developing countries

GSDI should partner and leverage diverse sources of funds and support

- Member countries, both for internal and external needs
- UN and international aid organizations
- Financial organizations
- Industry and foundations

Voluntary/in-kind contributions can be significant

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Securing and maintaining financial support and other resources to complete the organization's mission was a concern for all of the ten case study organizations. GSDI should develop a financial strategy and plan to support the organization as it grows. In such planning, GSDI needs to develop and employ creative sources of financial support and leverage resources through partnerships and other mechanisms. Most of the case studies employed a large amount of diversity, flexibility, and creativity in finding support, especially to help assist developing countries in finding the resources that they need.

GSDI should consider developing different funding sources for different activities. Most of the case study organizations had different sources for different types of activities. First, stable consistent funding was found for core operations, such as basic management and operational support. Some organizations, such as ICAO, ICSU and EUROGI, use membership dues to provide basic operating support, while others have the host country provide support, such as Secretariat support for PCGIAP and IGBP START's regions. Others find support from an international organization, such IPCC receiving UN support. Some of the regional SDI's are dependent on grants, special country contributions and international aid funds for their basic operations, such as EIS-Africa and PC IDEA. Both of these regional SDI's would like to find a more consistent and sustainable source of support, such as membership dues. GSDI could also develop an appropriate mechanism and strategy to ensure consistent long term financial support to sustain the basic operating support needed to run the

organization. Second, special funds are found for special projects and programs, such as providing technical assistance programs, and providing funds for special activities, such as EUROGI special project funding coming from the European Union and other sources. Another funding option to explore is where a percentage of regional SDI dues go to GSDI, perhaps to help with special regional projects.

Developing partnerships with existing organizations as much as possible is an extremely important part of a GSDI funding strategy. Most of the case study organizations were successful at leveraging funds and other resources in meeting their goals. They partnered in numerous ways to acquire needed resources. GSDI needs to follow such models and partner and leverage resources as much as possible. Formal and informal partnerships can both be used, as well as collaborative proposal writing for specific project funds. IGBP START provides a good model of such activities because it writes many collaborative proposals and partners extensively to achieve its mission of building regional networks for climate change science. For instance, support for the START Fellowship/Visiting Scientist and Guest Lecturer Programs comes from a number of sources, including the Dutch and Danish governments, UNDP, and the U.S. Agency for International Development. In fact given IGBP's needs and interests in GIS and geospatial data training and capacity building, GSDI should consider partnering with IGBP and trying to leverage off some of IGBP's activities. Many other organizations exist that GSDI might partner with in capacity building as well as other types of projects.

GSDI should try to cultivate a broad base of financial support to develop a robust and sustainable resource base. Sources of support can include member countries, UN and international aid organizations, financial institutions, industry, and foundations. Even international collaborations that have large operational infrastructures that have had large financial support have found that in recent years they must expand their resource base because of declining funds available for international activities. For instance, one of the main funding sources for technical cooperation in civil aviation had been the UNDP. However, such funds have been decreasing, so ICAO has been developing a range of non-traditional financial partners including not-for-profit inter-regional and regional development banks and financing institutions, international associations, and industry and service providers. Similarly, decline in WMO's regular budget sources has caused the WMO to give special attention to mobilizing resources from other sources, such as multilateral development banks, the private sector, and foundations. Successful organization's financial support evolved over time as needed.

GSDI also should take advantage of the fact that in-kind and other voluntary contributions can be significant. Many of the collaborative organizations took advantage of voluntary contributions. In fact a couple, ICSU and Global Map, are dependent on them. ICSU receives voluntary time and support from thousands of scientists around the globe. Global Map depends on members submitting their own country data in appropriate format.

Helping members, especially developing countries, find financial support for participation in GSDI and SDI related capacity building is another function that GSDI could perform. Many of the case study organizations help find funding for organizations, especially developing countries, to participate in their activities, such as finding other members who will donate travel funds. Many of the case study organizations also assist countries in finding resources for capacity building. For instance, WMO serves as a match-maker between donors and recipients in the WMO Voluntary Cooperation Programme. This activity channels bilateral and multilateral assistance of donor countries (about \$10-12 million/year) for technology transfer and training activities. Global Map matches member countries that can help provide data processing with other member countries that need help in processing their data to meet Global Map standards.

Develop Diverse Business Cases

The business case for participation in SDI activities differs because of differences in

- Regional and country needs
- Cultures and resources
- Organizational and technical backgrounds

GSDI should develop range of business cases for different needs and interests

Important to show appropriate economic benefits to developing countries, in areas like

- Agriculture and food production
- Trade and export of goods

Non-traditional issues also important motivators

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One activity that GSDI is focusing on is the development of an SDI/GSDI business case, meaning an economic rationale for SDI and GSDI participation. GSDI needs to develop diverse business cases to show countries and individuals the values of SDI and GSDI participation because of the different interests and needs of these target audiences. The target audiences for SDI activities vary by region, country, culture, organizational types, geospatial application interests and technical expertise, and resources available for SDI related activities. Such differences impact why and how individuals and countries choose to actively participate in national, regional and global SDI activities, and GSDI needs to develop different rationale that address these diverse needs. Many of the case studies addressed such differences by developing diverse and customized rationales for participation in their activities, such as the regional approaches discussed earlier to account for regional, local, and cultural differences.

The type of organization the individual works for and his or her technical background is another important dimension to consider when developing business cases. For instance, ICSU experience shows that what motivates individual scientists to volunteer their time in ICSU activities can differ from what motivates institutions to support ICSU activities. Institutions, such as governments, may care about improving local decision making, management, and allocation of resources; while individual scientists care about the professional interaction and networking with scientists from around the world; and both see benefit in the scientific recognition, and the prestige of contributing to an

international effort. Similarly, EIS-Africa originally built its collaboration based on the interests and understanding of environmental and national mapping organization professionals and now recognizes the need to broaden its network and focus on the interests of other organizations and disciplines such as transportation, telecommunications, agricultural, and economic development organizations.

Developing countries and developed countries will also have different motivations for SDI and GSDI participation. For instance, developed countries may participate because of the prestige of being in an important international or regional activity, diplomatic or political image, and because of seeing the broader public good benefits from the collaboration, as Global Map and EUROGI have experienced. Developing countries may participate because of the opportunities to build technical capacity and help improve their national economies, such as PC IDEA and EIS-Africa have experienced. Some rationale may motivate both types of countries, such as the educational networking and technical exchange opportunities. GSDI in its business case activities should show the appropriate economic benefits that the developing countries may receive as well as developed countries. Such activities should include specific examples and projects that are in applications areas of interest. For example, agriculture, food production, and environmental issues may be important to some countries and regions while transportation, trade and export issues may be more important to others. To illustrate these points, consider four diverse case study examples: EUROGI, ICAO, EIS-Africa, and PC IDEA. In Eastern Europe EUROGI held a workshop related to spatial data roles in agri-environmental programs because of former Soviet Union country interests. ICAO has convinced some Latin American countries to participate in ICAO's new air transportation infrastructure activities because the countries see how air transport will help the local economies, such as helping the export and tourist businesses. EIS-Africa has been able to start building African SDI collaboration because of grass roots projects and interests in sharing and using geospatial information to address environmental, natural resource, agriculture and food production needs in Africa. PC IDEA is focusing on developing country needs in the Americas by developing a capacity building strategy for land management with SDI concepts at its core.

Besides developing business cases for potential participants in GSDI activities, GSDI could also develop a business case for potential financial contributors to GSDI and other SDI related causes. Organizations that may provide financial support, such as international aid agencies and foundations, want to see different types of information from participants. For instance, potential funding sources

may care more about broad public good and GSDI specific related outcomes rather than specific country interests and SDI benefits. Measuring and highlighting the positive outcomes from GSDI and other SDI activities is an important part of developing such rationale.

In all of its business case activities GSDI could include both economic rationale and less quantifiable arguments, which also can be important for active participation by individual champions and countries. Such rationale can include a country choosing to participate because of a neighboring country participating, diplomatic image, or peer pressure, and individuals participating because of the prestige of participation and ability to travel to interesting conferences and meetings.

GSDI should identify its key audience types and their geospatial related needs and interests. Then GSDI could try to develop different lists by audience type of the rationale and benefits for participation in SDI and GSDI activities. Namely, GSDI should adapt business cases for regional and local needs and other differences in potential customer interests. Based on the case study analysis, we suggest several possible types of such business case lists. First, GSDI could develop lists by regions and sub-regions, such as Africa, Latin and South America, Asia, and the Pacific. Such lists should be developed in collaboration with the regional SDI's, especially since regional SDIs understand their regional needs. Some of the regional SDIs, such as PCGIAP and PC IDEA, have already conducted regional surveys to better understand their county and regional SDI needs. The FGDC and U.S. National Imagery and Mapping Agency (NIMA) sponsored survey of national SDIs is another useful resource in this process.⁹ Second, separate lists could be developed for developed and developing countries. Third, GSDI could develop benefits lists, (which emphasize economic ones) for different geospatial application areas such as environment, sustainable development, agriculture, transportation, and mapping. Fourth, GSDI could develop separate lists for potential funding organizations by types that are targeted toward these organizations' interests, such as lists for foundations, international aid organizations, and industry interests. Such lists could serve multiple purposes: helping decide where detailed business case documents are most needed and useful; understanding the commonalties and differences in SDI interests and needs; helping to market the GSDI organization and activities; and providing business case information for regional SDI use.

⁹ Onsrud, Harlan J., "A Global Survey of National Spatial Data Infrastructure Activities," University of Maine, Orono, Maine, undated.

Conduct Special Outreach for Developing Countries

Need to help developing countries

- Build capacity
- Find resources for participation

Mechanisms employed, could include aiding with

- Technical assistance
- Travel funds
- Special and customized business cases
- Basic infrastructure development
- Regional forum and workshops
- Development and support of regional and local champions and personal relationships

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Developing countries often do not have the financial resources, technical skills and infrastructure for developing SDI in their own countries, let alone participating in GSDI. GSDI needs to conduct special outreach to developing countries so they can participate in national, regional, and global SDI activities. Specifically, GSDI needs to help developing countries find resources for participation in GSDI and to help them build technical capacity to be able to use, maintain, and share geospatial data. The latter may include basic IT capacity building before SDI specific capacity building can be effective. For instance, in one South Asian country scientists could not afford access to the Internet, so IGBP START helped to find the funding for their Internet connectivity so the scientists could participate in the organization's activities. All of the ten case study organizations conducted some sort of special outreach to developing countries because of these countries physical and intellectual needs for basic technical infrastructure development.

GSDI could employ many different mechanisms to outreach to developing countries, as the case study organizations do. For instance, the WMO published developing country needs in a newsletter; helped matched donors who were offering assistance with appropriate recipients; organized training classes, seminars and materials; and helped establish training programs and regional training centers. Similarly, EIS-Africa is working to provide workshops, best practice documents, training centers, and educational materials. Developing a regional and local network of dedicated champions and institutions as partners,

communication channels, and supporters is a key part of such capacity building, as EIS-Africa also has learned. Another example of a creative mechanism that helps engage developing countries and build intellectual capacity is how the IPCC has co-chairs from developing and developed countries chairing all the organization's working groups.

Such mechanisms range from simple, low-cost activities, like providing travel funds for attending meetings, to more expensive formal programs, such as regional training centers and technical cooperation programs to provide in depth technical assistance, such as ICAO and IGBP START provide. Other lower costs examples include providing regional forum and workshops to help with education and training needs (used by PC IDEA), and providing educational and training materials (used by EIS-Africa).

Helping to meet basic IT and other infrastructure development needs can be an important prerequisite before countries can participate in a national or regional SDI, not to mention GSDI. Many of the cases highlighted the need for such technological infrastructure support. For instance, because of new satellite technologies WMO is working to encourage donations of appropriate data processing equipment and training in developing countries so it can provide more accurate global weather data.

As has already been discussed, GSDI could adapt such activities to the unique regional and local needs. For example, IGBP START distributes geospatial data by CD's in South East Asia because it is too expensive and difficult for developing country scientists to share large geospatial data through the Internet. In addition, special and customized business cases need to be developed to meet the developing country economic needs that will vary by region and even by nation. Grass roots project specific activities can also be an effective way to help build capacity in developing countries, such as ICSU local scientist experience in implementing capacity building activities in Africa.

Other Lessons for GSDI

Formal and informal partnerships are critical

Appropriate economic and other benefits need to be articulated and developed for

- GSDI participation
- Regional and national SDI activities

Organization needs to be perceived as

- Fair and neutral
- Consensus building process

On-going communication and coordination is critical, including meetings, workshops, web, procedures, standards, and documents

RAND

In the case study analysis some other lessons stand out for GSDI, many of which have already been alluded to, but four are worth mentioning specifically:

(1) GSDI should develop formal and informal partnerships to leverage resources and support, and to increase visibility, participation, and credibility of the organization.

(2) Appropriate benefits need to be developed and clearly articulated for both GSDI participation and also for regional and national SDI activities, recognizing that there will be some overlap and differences in such benefits. Such benefits should be widely distributed and posted on the GSDI web site.

(3) The organization needs to be perceived as fair and neutral and promote consensus building. Many of the case study organizations, such as IGBP START, PCGIAP and PC IDEA, found that such factors were important to their credibility and building long term success.

(4) Having on-going effective communication and coordination mechanisms is critical to the success of the collaboration, and that such mechanisms should include a range of techniques including workshops, conference calls, e-mail, web sites, best practice documents, procedures, and standards.

Conclusions

Wealth of information from other organizations' experience for the GSDI

Important for GSDI development and implementation

- To be flexible and creative
- Evolve over time
- Leverage funds, talent, and expertise

Opportunity for GSDI to grow and contribute to key global developments

RAND

GSDI has an opportunity to grow and contribute to key global geospatial activities, and even more importantly the issues and decision making processes that geospatial data and infrastructure can contribute to, such as sustainable development, economic growth, security and safety, and other public good issues.

GSDI has already taken many positive steps on such a path. To fully achieve such potential, GSDI can learn from a wealth of experience from international collaboration and regional SDI activities. Many different options, approaches, and mechanisms are possible for GSDI's development and implementation. As GSDI evolves and grows over time it is important that the organization allow for creativity and flexibility since it will experience some growing pains and need to adapt to future technological, financial, social and other types of changes. To be able to find the financial, institutional and individual support needed to achieve its mission GSDI needs to leverage funds, resources, and enthusiastic, knowledgeable and experienced individuals.

4. The Case Studies

Detailed Descriptions of the Case Studies

- **Six international case studies**
- **Four regional SDI case studies**
- **Some additional case studies with useful insights**

RAND

In describing each case study, we briefly survey the key features, such as mission, activities, members, finances, and structure. We then provide some of the relevant lessons learned from that case for GSDI. Each case is summarized with 4-6 charts and about the same number of pages of text. In such a brief description, we cannot capture all the information we gathered, or even all the details on the lessons learned for GSDI; therefore, we have attempted to highlight the most relevant or interesting points from each case. Note, that these cases were written so they can be read independent of the analysis, which causes some repetition with the front part of this document.

Global Map

International collaboration mostly by national mapping organizations to

- Develop standardized global map data
- Disseminate data at marginal cost to public
- Help us understand global environmental changes and future challenges

Global map consists of

- 1 km resolution digital geographic information
- 8 basic layers
- Updated at about 5 year intervals

RAND

Started in 1992, Global Map¹⁰ is an international collaboration to develop global scale geographic information. The objective of Global Map is to help countries throughout the world understand the nature and the magnitude of current and future global environmental changes. Global Map is providing basic geospatial data covering the entire land area of the earth at 1 km ground resolution. As agreed upon by the collaboration, each theme will be provided in a common open standard, Vector Product Format (VPF) for vector layers and Band Interleaved by Line(BIL) format for raster layers.¹¹ The data will be available to anyone at the marginal cost to reproduce and supply the data.

The data are composed of eight basic geospatial layers: elevation, vegetation, land-use, land cover, drainage systems, transportation, population centers, and administrative boundaries. Current plans are that the Global Map data will be updated about every five-years. Individual countries have the main responsibility for providing the data. As of July 2001 only nine countries had completed their Global Map data. Many countries have found it more time-consuming than originally anticipated to generate and process the data into the

¹⁰ For more information on Global Map see:
<http://www.iscgm.org/iscgm.html>

¹¹ For more information about these formats see Global Map, "Global Map Version 1.1 Specifications," March 16, 2000.

specified format. Full completion of all the Global Map datasets will likely take a couple of years or more.

Global Map Structure

International Steering Committee for Global Mapping (ISCGM)

- Facilitate, advocate, and foster Global Map development
- Established in 1996 and meets yearly
- Secretariat at Geographical Survey Institute, Japan

Collaboration membership

- 84 participating countries and regions
- 34 countries and regions considering participation
- 3 different categories for participation

RAND

The International Steering Committee for Global Mapping (ISCGM) is the organization that governs the Global Map collaboration. ISCGM facilitates, advocates and fosters the development of the Global Map data. Established in 1996 this committee meets yearly and consists of the heads of national mapping organizations from sixteen countries, as well as representatives of international organizations, and seven invited advisers from UN organizations and academic institutions. The Secretariat for ISCGM is located in Japan.

National mapping organizations are the main participants in the development of the Global Map data. These organizations were invited to participate by an official letter from the United Nations. As of July 2001 eighty-four countries and regions were participating and an additional thirty-four countries and regions were considering participation. The fact that so many countries have been brought together and have agreed to share global geospatial data in public is a significant accomplishment of this collaboration.

Countries have three options in how they participate, called levels A, B, and C. Level A countries can provide the data for their own country and lend some expertise to other countries, such as helping to digitize paper maps and converting data. Level B countries can provide their own country data, but cannot help others. Countries which do not have the resources and/or technical skills to generate Global Map data are level C countries and they may obtain help from the level A countries.

Global Map's organization and activities are very structured, which is both a strength and a weakness. Such structure is a strength because it has helped the collaboration focus, develop relationships with other organizations, and increase country participation. However, such a strict structure, at times, can be a weakness because it sometimes can make it more difficult for an organization to respond to changes and to be innovative.

Global Map Funding and Membership Issues

Support from

- Japanese government for basic operating expenses
- Countries incur costs of providing data, except for those that need help from other countries
- Some Regional SDI's producing Global Map data

Membership expansion strategy

- Emphasizing benefits
- Individual countries are conducting special outreach, especially with developing countries

Benefits of country participation

- Networking opportunity
- Regional and country peer pressure

RAND

Global Map's financial support comes from a number of different sources, but it mostly depends on voluntarily contributions related to data processing. The Geographical Survey Institute of Japan provides support for the ISCGM secretariat. Individual countries of level A and B are responsible for providing their own data in the required format. Level C countries with insufficient resources and/or technical skills to produce their own data may obtain help from level A countries. For example, Japan has offered help to some level C countries in Asia and Africa. Some regional SDI collaborations, such as PCGIAP and PC IDEA are helping to create global map data for their regions. Members of EuroGeographics have come to the conclusion that European national mapping organizations wish to work together on the Global Mapping project and to create "EuroGlobalMap," which will be completed in 2002. In addition, in May 2001 the GIS vendor ESRI offered to provide some funding for a grant program for Global Map and GSDI participation by developing countries. Specifically, ESRI will supply the national mapping organizations of some developing countries with free software and training so they can create and maintain their global map data.

Global Map is trying to expand membership by emphasizing benefits of participation and with special outreach activities, mostly oriented towards developing countries. Benefits include: networking with experts, helping to keep up with latest technology developments, and the prestige of participating in an international activity with an official UN invitation. Given the large number of countries participating, peer pressure also factors into motivating participation.

Some countries may feel if they do not participate that they will be excluded from the international national mapping organization activities. Special outreach to countries with fewer resources, such as the ESRI grant program, also helps increase participation. Another example of an incentive program facilitating participation is that the Japan International Cooperation Agency conducts some training courses in Global Mapping techniques to help build technical capacity in developing countries. Diplomatic image and having worldwide consistent datasets are other benefits perceived by countries from Global Map activities. In this context, ISCGM urges participants of Global Mapping to brief their government agencies responsible for World Summit on Sustainable Development (Rio+10) on the importance of Global Map to the objectives of the conference.

Global Map Lessons Learned for GSDI

Focus on specific activities

Define relationships and develop partnerships with related organizations

- Global Map helping countries to develop regional SDIs and GSDI participation

Implement special outreach for developing countries

- Encourage developed countries to work with less developed countries in their region
- Special grant programs

Emphasize and promote benefits of participation

RAND

Global Map has important similarities with GSDI. These include its global scope, focus on geospatial data, and ability to facilitate geospatial collaboration. This collaboration is slightly different, since it emphasizes a specific physical data product rather than spatial infrastructure development. However SDI development is an important synergistic activity with Global Map. Therefore, this international collaboration provides a number of relevant lessons learned for GSDI collaboration. It is important to note that Global Map has only been in operation for about five years, so the organization does not yet have much operational history, but Global Map still offers some insights for GSDI.

First, GSDI should focus on specific projects because such projects can help engage participants and educate them about the importance of SDI activities, such as the importance of metadata and collaboration. By focusing and participating in developing a specific data product in Global Map activities, helps more countries recognize the importance of GSDI activities.

Second, GSDI should develop partnerships and define relationships with other relevant regional and international activities. Defining relationships and developing partnerships with other relevant regional and international organizations helps leverage resources, increases visibility, and increases membership. For example, the UN providing an official invitation letter to NMOs to participate in Global Map gave the activity credibility and was instrumental in motivating countries' participation. Such partnerships can provide synergy and benefits for all the partners. For instance, partnering with

PCGIAP and PCIDEA helps increase global map data development and also helps these organizations in developing their regional collaborations.

Third, GSDI needs to develop special activities and outreach to help developing countries participate in such international collaborations since they often do not have the resources to participate in such activities. An important mechanism for such outreach is facilitating country-to-country technical aid, such as the Level C and Level A membership categories in Global Map. Special grant and assistance programs are also helpful, such as the Japan International Cooperation Agency training classes and the ESRI grant program.

Last, GSDI should emphasize and promote the benefits of GSDI participation. Such promotion is needed to increase active participation in the organization. Global Map is currently working to distribute such a message to its members to increase active participation in Global Map.

International Civil Aviation Organization (ICAO)

International collaborative organization for air transport infrastructure development

Objectives

- **To develop the principles and techniques of international air navigation**
- **To foster the planning and development of international air transport**

Activities

- **Help promote, develop, and establish standards, recommended practices and procedures for technical areas of aviation**

RAND

The International Civil Aviation Organization (ICAO)¹² is widely recognized as being an effective collaborative organization for developing a global interoperable international air transportation system.

ICAO's objectives are to develop the principles and techniques of international air navigation and to foster the planning and development of international air transport so as to:

- "a) ensure the safe and orderly growth of international civil aviation throughout the world;
- b) encourage the arts of aircraft design and operation for peaceful purposes;
- c) encourage the development of airways, airports, and air navigation facilities for international civil aviation;
- d) meet the needs of the peoples of the world for safe, regular, efficient and economical air transport;
- e) prevent economic waste caused by unreasonable competition;
- f) ensure that the rights of Contracting States are fully respected and that every Contracting State has a fair opportunity to operate international airlines;
- g) avoid discrimination between Contracting States;

¹² See ICAO home page for more information: <http://www.icao.int/>

- h) promote safety of flight in international air navigation;
- i) promote generally the development of all aspects of international civil aeronautics."¹³

This organization works to promote, develop, and establish standards, recommended practices and procedures for technical areas of aviation and to help all countries throughout the world adapt and follow such practices. Over 185 countries, official Member States of ICAO, follow such practices.

¹³ From <http://www.icao.int/cgi/goto.pl?icao/en/aims.htm>

ICAO UN-based Organizational Structure

Sovereign body -- the Assembly

- Each Contracting State is entitled to one vote
- Decisions are majority vote

A governing body -- the Council

- Permanent body responsible to the Assembly
- Composed of 33 Contracting States elected by the Assembly
- Ensure that all the major geographic areas of the world are represented

Numerous working committees, including

- Air Navigation Commission, the Air Transport Committee, the Legal Committee, the Finance Committee, the Committee on Unlawful Interference, the Personnel Committee and the Technical Co-operation Committee

RAND

ICAO was started in 1944 so the organization existed before the UN. In 1951 ICAO became a special UN agency. The organization has a formal structure, because formal standards and procedures are needed, for items such as air navigation, and airport and aircraft operations, to ensure a safe, consistent and integrated air transport infrastructure. ICAO follows the principles of the UN, however, ICAO could operate totally separately from the UN given the independence of ICAO's current operations.

ICAO has a sovereign body, the Assembly, which meets at least once in three years. Within the Assembly, each Contracting State is entitled to one vote and decisions are based on majority vote. The Assembly reviews the organization's technical, economic, legal and technical co-operation work and provides guidance to the other bodies of ICAO for their future work.

The Council, a governing body for ICAO, is a permanent body responsible to the Assembly and is composed of 33 Contracting States elected by the Assembly for a three-year term. The Council works with ICAO committees to carry out the main work of the organization. Part of the Council's work includes taking whatever steps are necessary to maintain the safety and regularity of operation of international air transport, such as investigating any situation which presents avoidable obstacles to the development of international air navigation.

ICAO has numerous committees to work on specific issues, including the Air Navigation Commission, the Air Transport Committee, the Legal Committee, the Committee on Joint Support of Air Navigation Services, the Finance Committee,

the Committee on Unlawful Interference, the Personnel Committee and the Technical Co-operation Committee.

ICAO also works with numerous other organizations, such as the International Air Transport Association (IATA) and UNDP, in achieving its goals.

ICAO's Finances and Operations

Funding

- Basic operating expenses provided by members
- Numerous sources to assist developing countries

Communications, navigation, surveillance/air traffic management (CNS/ATM) concept

- Satellite-based system to meet future needs
- Developing standards, recommended practices and guidance materials
- Must convince countries to implement

Regional planning infrastructure

RAND

Most of ICAO's financial support comes from its members, i.e. countries, using a UN-based formula. Such funds cover the organization's main operating expenses. However, the organization also works with Member States, mostly the developing countries, to locate funds to implement appropriate air transport infrastructure. Such capacity building includes training, education, and the acquisition of physical equipment. One of the main funding sources for technical co-operation in civil aviation had been the UNDP. However, such funds have been decreasing, because it is not as high a priority for UNDP as other areas. In addition, global trends of placing air transportation infrastructure in private hands makes it more difficult to acquire government based financing.¹⁴ Therefore, ICAO has been developing a range of non-traditional financial partners including not-for-profit inter-regional and regional development banks and financing institutions, international associations, and industry and service providers.

Recently ICAO has developed a satellite-based system concept to meet the future Communications, Navigation, Surveillance/Air Traffic Management (CNS/ATM) needs of civil aviation. The CNS/ATM concept applies today's high technologies in satellites and computers, data links and advanced flight

¹⁴ See Atterman, Neal H., *The Changing Role of Debt in Global Air Transport Infrastructure Finance*, 1997, for more information about this changing financial situation.

deck avionics, to cope with tomorrow's growing operational needs. This system will make obsolete much of today's expensive ground-based equipment, which uses line-of-sight technology and has inherent limitations and produce greater efficiencies and greater safety. This system is a new frontier for aviation because it is an integrated global system with significant changes to the way air traffic services are organized and operated. The CNS/ATM systems concept has been approved and is now in its implementation phase, which includes the development of standards, recommended practices and guidance materials.

CNS/ATM is an instructive parallel for GSDI because ICAO must facilitate the development and implementation of this infrastructure worldwide and the organization depends on individual nation's actions. Like SDI concepts, the CNS/ATM is a new technology system and approach which many countries may not see the need to implement. ICAO has to convince countries of the economic benefits of this new approach, help them build the capacity to handle the new systems, and help developing countries find funds to implement it. Business plans are being developed by ICAO to help demonstrate the need for and benefits from investing in the CNS/ATM system. For instance, in Latin American countries, ICAO convinces countries to invest in the new technologies because it will improve system efficiency and help the economy, such as helping the export and tourism industries. Local and regional terrain and topography also can be convincing arguments, such as the new satellite-based navigation technologies having advantages over the ground based equipment in the vast jungle and mountainous areas of Brazil.¹⁵ ICAO also provides countries with information about how to conduct a cost benefit analysis to improve the efficiency of system implementation.¹⁶

ICAO has found that the best way to develop a global air transport infrastructure is to take a regional approach and has developed regional planning infrastructures. Originally the organization tried to work with individual countries using the same approaches worldwide, but ICAO learned that different regions have different needs, resources, and cultures, and needed different approaches. For example, ICAO used to develop its own training program, but now it helps regions set up regional training programs that meet regional needs.

¹⁵ For more details on Brazil's involvement in CNS/ATM see Lima, Edvaldo Pereira, "Brazil Committed to International Cooperation," 1997.

¹⁶ For more details on such information see Nelson, Andrew, *CNS/ATM Decision Making Tools: Technical Audit and Cost Benefit Analysis*, 1997.

ICAO Membership Development Activities

Regional activities to support seamless global air traffic management system

- Nine planning regions
- Regional air navigation meetings lead to integrated efficient system for region and globe
- Regional offices provide technical assistance

Technical co-operation for development, especially for developing countries

- Countries solicit help from Technical Co-operation Bureau
- Help match with needed training and expertise
- Help develop national and regional training centers
- Provide technical co-operation missions to countries

RAND

ICAO has numerous regional activities to support a seamless global air traffic management system. Regional air navigation meetings lead to a more integrated and efficient system for regional and global air traffic management. ICAO uses nine different planning regions to cover the globe and has regional offices which help facilitate regional and national developments. These offices help build regional organizations, independent autonomous regional bodies that address different regional and country needs and cultures. These regional offices also provide technical assistance, especially helping to facilitate capacity building in developing countries.

A large amount and range of technical assistance activities are employed by ICAO. In 1999 ICAO helped find technical funds for \$54.3 million worth of assistance activities, which included executing 126 projects in 72 developing countries.¹⁷ The Technical Co-operation Committee and Technical Co-operation Bureau take the lead on facilitating such technical assistance throughout the globe. Assistance includes advising on the organization of government civil aviation departments and on the location and operation of facilities and services, helping to recruit and train experts, providing fellowships training and helping with the procurement of equipment. ICAO has helped establish civil aviation training centers in, for example, Egypt, India, Indonesia, Jordan, Kenya, Morocco, Nigeria, Pakistan, Thailand and Tunisia. Such regional training centers usually

¹⁷ ICAO, "Annual Report of the Council, 1999," p. 15.

take students of many nationalities and the local governments pay a large share of the costs and eventually takes over complete operation of the projects.

Nationals of many countries have received ICAO fellowships for study abroad. ICAO also helps put together technical co-operation missions, consisting of one or more technical experts which go to countries that need assistance.

Countries solicit help from the Technical Co-operation Bureau, which helps find the resources and technical expertise that the countries need for a specific project, which can be just about anything related to air transport issues, everything from training an air traffic controller to helping to build a new airport. In this assistance the Technical Co-operation Bureau makes sure all phases of the project are covered including: project identification, project assessment and formulation support in arranging funds and project implementation. In 1999 the Technical Co-operation Bureau employed 366 experts from 41 countries to work in such field projects.

ICAO Lessons Learned for GSDI

Use regional approaches and collaboration

- Help develop and work with regional activities in support of global organization
- Adapt approaches for regional and country needs
- Facilitate communication and coordination

Promote the harmonization of standards

Promote and provide technical co-operation and training, especially for developing countries

- Technical exchange
- Technical co-operation missions to countries
- Information about funding sources
- Training classes, centers, and materials

RAND

At first glance ICAO may not seem that relevant to GSDI because it is a very large organization that develops and employs standards, that focuses on an operational physical infrastructure, and that deals with legal and safety issues, and many other things that are not directly parallel to GSDI's role. However, there are many similarities within parts of ICAO activities, including its facilitation role, promoting an infrastructure that needs geospatial technologies and data, its global focus, and a need to facilitate technical capacity building. ICAO's development and implementation of the CNS/ATM concept is especially relevant because ICAO must work hard with regions and countries to convince them to implement this new approach and this new technology based infrastructure, and to help them build the technical and financial capacity to be able to implement it. In addition, ICAO's long history and success at finding support, providing technical assistance to developing countries, and creating a truly global and integrated operational system provides useful information about international collaboration. Given all these things ICAO offers a number of useful insights for GSDI development and implementation.

First, GSDI should use regional approaches and collaboration to meet local needs. ICAO found that the organization needed to know the specific needs of each region and country, and then adapted its activities accordingly. For example, ICAO found that people learn better in their own cultures and languages so they adapted training materiel for different regions and actually used the cultural strengths of the region to help develop regional training centers. GSDI should

work through regional organizations and help develop regional collaborations designed for regional needs. An important part of this process is facilitating communication and coordination with the region, as the ICAO regional centers did.

Second, GSDI should promote the harmonization of standards. ICAO develops minimal standards and allows individual countries to implement higher standards as long as such standards work with the ICAO standards. Such a harmonization strategy allows regions to adapt for their own needs, yet still be able to integrate their data and information within the global system.

Third, GSDI needs to promote and provide technical co-operation and training, especially to help developing countries build needed capacity. Such assistance needs to focus on matching regional and country needs with appropriate funding and technical assistance. For countries around the world to implement an integrated air transport infrastructure, ICAO needed to help the countries acquire, implement and maintain the appropriate technical expertise and systems, such as with the CNS/ATM concept. Without the appropriate skills and resources many nations will not be able to participate in GSDI. There are many different options to help build capacity that GSDI could experiment with. Successful mechanisms that ICAO used included helping countries finding project funding, providing technical co-operation missions from developed countries to developing countries, helping to develop regional training centers, and providing fellowships for training abroad. Having parts of the organization dedicated to technical co-operation was an important part of ICAO's success in technical capacity building. Also, being strategic and creative in finding financing, especially as traditional resources started disappearing has been important to ICAO maintaining such activities.

International Council for Science (ICSU)

NGO that brings together scientists in international scientific endeavors

- Initiates and coordinates major international interdisciplinary programs
- Creates interdisciplinary bodies which undertake research programs of interest to members

An association of associations

- 26 International Scientific Union members are international single disciplinary organizations
- 98 National Scientific Members are national multidisciplinary bodies

RAND

Founded in 1931, the International Council for Science (ICSU)¹⁸ is a non-governmental organization which brings together natural scientists in international scientific endeavor. This international collaboration's main purpose is increasing scientific collaboration throughout the world.

ICSU is an association of associations. The Council's members consist of 98 multi-disciplinary National Scientific Members (scientific research councils or science academies)¹⁹ and 26 single-discipline International Scientific Union Members.²⁰ International Scientific Union Members are international, non-governmental, professional organizations working in a particular area of science and have been in existence for at least six years. Both categories of members have full voting rights, while associate members and observers may not vote. National Scientific Associates qualify for membership, but are not yet ready for full membership, and observers are those members which have failed to fulfill their financial obligations. In addition, ICSU has 24 International Scientific Associates and 4 Regional Scientific Associates. Such a large collaboration network provides a wide range of scientific expertise enabling members to

¹⁸ Note that ICSU used to be called the International Council of Scientific Unions. For more information on ICSU see <http://www.icsu.org/>

¹⁹ These members include 75 full Members, 15 National Scientific Associates and 8 National Scientific Observers. For a list of the full National Scientific Members see: <http://www.icsu.org/Membership/NSM.html>

²⁰ For more information on the International Scientific Union Members see: <http://www.icsu.org/Membership/SUM.html>

address major international, interdisciplinary issues which none could handle alone.

The Council initiates and coordinates major international interdisciplinary programs and creates interdisciplinary bodies which undertake activities and research programs of interest to multiple or all members. Capacity building in science, environment and development, and the free conduct of science are examples of the latter, i.e. issues that concern all scientists. The Council also provides a forum for the exchange of information and the development of standards. Hundreds of congresses, symposia and other scientific meetings are organized each year around the world, and a wide range of newsletters, handbooks and journals is published.

ICSU's objectives and fundamental principles are set out in its Statutes and Rules of Procedure, and must be adhered to by all members. The universality of science (Statute 5) is one of these fundamental principles and it "affirms the right and freedom of scientists to associate in international scientific activity without regard to such factors as citizenship, religion, creed, political stance, ethnic origin, race, colour, language, age or sex."²¹

Over time ICSU has built up a level of international recognition and prestige which means scientists and organizations want to be associated with it.

²¹ ICSU Statutes at <http://www.icsu.org/Structure/statutes.html>

ICSU's Structure and Relationships

Governing bodies

- General Assembly, Executive Board, and Officers
- Secretariat responsible for daily work

8 Standing committees, including

- Scientific Planning and Review
- Governance
- Finance and Fund-raising
- Dissemination of Scientific information
- Science and Technology in Developing Countries

25 Interdisciplinary ICSU bodies

Joint initiatives with other organizations, such as
UNESCO, WMO, UNEP and FAO

RAND

ICSU is governed by a the General Assembly, an Executive Board and Officers. These organizations are assisted by a Secretariat responsible for the day-to-day work of the Council. The Council has a formal structure, but it is less formal than the UN and ICAO.

ICSU has eight standing committees, that provide policy and advisory services. These standing committees are:

- Scientific Planning and Review
- Governance
- Finance and Fund-raising
- Freedom in the Conduct of Science
- Responsibility and Ethics in Science
- Dissemination of Scientific Information
- Science and Technology in Developing Countries
- Environment

Each of these bodies report to the Executive Board or the General Assembly.

Interdisciplinary ICSU bodies are created to facilitate and coordinate international interdisciplinary scientific and educational activities. There are currently 25 such bodies, such as International Geosphere-Biosphere Programme (IGBP), Scientific Committee on Solar Terrestrial Physics (SCOSTEP), Scientific Committee on Problems of the Environment (SCOPE), and the Committee on Data for Science and Technology (CODATA). CODATA seeks to improve the quality, reliability, management, and accessibility of data for science and technology collaboration.²²

ICSU is totally independent from the UN, but it has many joint initiatives with various UN agencies, and other organizations. Technically, joint initiatives are international programs conducted in partnership with other inter- or non-governmental organizations. Such joint cooperation occurs in nine major initiatives with organizations such as the United Nations Educational, Scientific, and Cultural Organization (UNESCO), WMO, UNEP and FAO.

²² For more information about CODATA see http://www.codata.org/codata/data_access/index.html. Also, GSDI members may want to examine this activity more thoroughly regarding intellectual property and data policy differences, especially because of the CODATA/ICSU Ad hoc Group on Data and Information, which was established to examine problems, policies, and possible solutions to issues of international access and exchange of data for scientific research. This Ad hoc Group on Data and Information deals with problems of intellectual property rights and free access to data. See: http://www.codata.org/codata/data_access/group.html

See also: "Access To Databases Principles for Science in the Internet Era" at http://www.codata.org/codata/data_access/principles.html

ICSU Financial and Other Resources

Yearly central budget over \$3.5 million

Main source of financial support

- Contributions from Members

Other sources of funds support the scientific activities of the ICSU Unions and interdisciplinary bodies

- Framework contracts from UNESCO
- Grants and contracts from UN bodies, foundations and agencies

Voluntary time contributed by thousands of scientists committed to ICSU objectives

RAND

ICSU's yearly central budget is over \$3.5 million (US), while the entire family of ICSU activities budget is over \$15 million (US). The main source of financial support is contributions from members. Members are required to contribute dues, and each country has to find its own funding for members. For example, according to a U.S. National Academy of Science(NAS) member, some American scientists write proposals to the U.S. National Science Foundation to help provide NAS's association contributions to ICSU. The United States contributed over \$230,000 in 2000. Members from developing countries pay far less, for example, \$1000 to \$1500 per year.

Other sources of income include the framework contracts from UNESCO and grants and contracts from UN bodies, foundations and agencies. These funds are used to support the scientific activities of the ICSU Unions and interdisciplinary bodies.

In addition, ICSU receives voluntary time and support from thousands of scientists around the globe. This contribution is significant and one of the Council's greatest strengths.

ICSU Participation Issues

Explains to scientists why participation is a worthwhile time investment

- **Scientific recognition and networking**
- **Contributing to an international effort**
- **Leads to better management, decision making, and allocation of resources**
- **Can help facilitate researchers receiving support by the government**

Employs special outreach to developing country scientists

- **Providing travel funds**
- **Having committees focused on their needs**

RAND

Over the years ICSU has articulated the benefits of participation in the organization and worked hard to build a good reputation so that scientists want to participate in ICSU activities. Such articulation of the benefits is especially important to elicit and maintain financial support, especially from national Members. What motivates scientists to volunteer their time in ICSU activities can differ from what motivates Academies and others to contribute funds, so ICSU articulates a range of benefits. The benefits include: the scientific recognition for both the country and participating scientists; the prestige of contributing to an international effort; an opportunity to improve local decision making, management, and allocation of resources; and a chance to increase support for the local scientists' research. Individual scientists also benefit from the professional interaction and networking with scientists from around the world, which is especially important to developing country scientists. Receiving travel opportunities and funding to attend international meetings in other countries is another benefit for developing country scientists. However, the ICSU Committee on Scientific Planning and Review believes that ICSU's contribution to developing countries science and technology should be more than just providing travel funds, so they have been working on ICSU strategies to advance developing countries science and technology activities.

In its activities, ICSU also employs special outreach to help developing countries participate, such as having the Committee on Science and Technology in Developing Countries (COSTED). Basic scientific and technology infrastructure

is poor in many developing countries, so to facilitate these countries' participation it is important to help build such capacity. In some cases, ICSU activities, such as local in the field efforts, do this by helping to find funding to cover the cost of acquiring equipment, training and education at the local level. In some cases, such training or equipment may be low cost. Therefore, at times, it is important to think smaller when working with developing countries compared to working with developed countries. For example, some African scientists were offered a \$100,000 grant to help start an Internet access project, but the scientists only wanted around \$10,000 to hold a workshop, purchase some initial equipment, and test their ideas. The scientists wanted the smaller amount of funding because they wanted the "freedom to fail" and with the larger amount of money they would not be allowed to fail.²³

In some cases, travel funds are also found for developing country scientists to attend meetings in their own country and internationally. For example, in some cases, a person from a rural area attending a meeting in a capital city of his or her own country can be as important as attending a meeting in a foreign country thousands of miles away.²⁴

²³ This example comes from the personal experience of an ICSU associated NAS scientist who has worked extensively in Africa. One of the strengths of ICSU's family of activities is that there is the opportunity for on the ground local experience where developed country scientists can participate directly in developing country efforts.

²⁴ Ibid.

ICSU Lessons Learned for GSDI

Build personal ownership with

- People being involved throughout the process
- Consensus building

Be creative and flexible in acquiring financial support

Find appropriate help and support for training and infrastructure in developing countries

- Need to have at regional and local level
- Often basic and low cost needs

Recognition an important motivator

Impact of “pioneers” can be significant

RAND

Many of the ICSU activities that deal with data are similar to the GSDI in a number of ways: facilitating an international collaboration process, being global, focusing on activities that require a high level of knowledge and technical or scientific expertise, and conducting science activities where much of the data has a geospatial component. ICSU differs in focusing more on science than technology and being more oriented towards scientists, though the organization's activities depend on technical infrastructure, such as information technologies. ICSU also has a long history of collaboration in the global context and relying on volunteers to support the organization. Given all these reasons, ICSU experience offers some useful collaboration lessons for GSDI development.

First, people need to feel personal ownership in the process. It is important for GSDI to take the time to have everyone involved throughout the process, especially engaging developing country members. Based on our assessment of some of the ICSU experiences, this process appears to take longer and cost more, but the process builds a stronger, more highly regarded, and more effective organization in the long run.

Second, GSDI should acquire funds and support through many different creative approaches and mechanisms to support diverse project needs. Sometimes the support may seem indirect to the organization's mission, but it may be a necessary first step to gaining participation, such as capacity building in developing countries. For example, an African-based scientist associated with ICSU activities helped acquire Carnegie Foundation funding for basic technical

capacity building and training in Africa, with a focus on Internet issues. This technical capacity eventually helped enable African scientists to participate in ICSU activities because of their new ability to connect and participate in Internet based activities.

Third, GSDI should help facilitate training, education and technical infrastructure development in developing countries. Many of these countries need aid before they can participate in such a technical area as spatial data collaboration. One cannot assume developing countries' technical experts and government officials are fully skilled in the use of information technologies or have regular dependable access just because they send e-mail once in a while. They need IT training and support. Often such support is for basic and low-cost needs. GSDI needs to listen to and understand the regional and individual country needs and tailor such support to the regional and local level. Also, RAND found, based on ICSU field experience, that, in some cases, it is important to think smaller when working with developing countries. Sometimes even providing larger amounts of funding is not necessarily a good thing, as the African scientists wanting the "freedom to fail" example illustrated.

Fourth, recognition can be a good way to motivate people's participation in the organization, for example, ICSU activities have published participants' conference papers and activities in formal publications.²⁵ Such a simple and fairly low-cost activity can have a significant impact on helping build the reputation of the organization and help gain and keep active participants.

Last, the pioneers are useful champions for the organization's cause. GSDI should find and encourage such catalysts. ICSU benefits significantly from the thousands of scientist volunteers, many of whom are the best champions for its activities.

²⁵ For an example of such a publication see: National Research Council, "Bridge Builders: African Experiences with Information and Communication Technology," 1996.

International Geosphere-Biosphere Programme (IGBP)

**Interdisciplinary scientific activity established and
sponsored by the ICSU**

Objective

- Acquiring scientific knowledge about the interactive processes of biology and chemistry of the earth as they relate to global change

IGBP provides

- An international, inter-disciplinary framework for the conduct of global change science
- A means for co-ordinating activities in various scientific disciplines
- For fostering the integration of results

RAND

In 1986 ICSU instituted the International Geosphere-Biosphere Programme (IGBP)²⁶ as an interdisciplinary scientific activity. IGBP provides an international, inter-disciplinary framework for the conduct of global change science by focusing on acquiring scientific knowledge about the interactive processes of biology and chemistry of the earth as they relate to global change.

IGBP's goal is:

"To describe and understand the interactive physical, chemical and biological processes that regulate the total Earth system, the unique environment that it provides for life, the changes that are occurring in this system, and the manner in which they are influenced by human actions."²⁷

Priority is placed on studying areas that deal with key interactions and significant changes on time scales of decades to centuries, that most affect the biosphere, that are most susceptible to human impact, and which will most likely lead to a practical, predictive capability.

IGBP provides a process for coordinating activities in various scientific disciplines, and for fostering the integration of results towards the development

²⁶ For more information about IGBP see the organization's web site at:
<http://www.igbp.kva.se/>

²⁷ From <http://www.igbp.kva.se/secretar.html#anchor2179048>

of a holistic picture of global processes and how change affects them. IGBP tries to provide the best possible scientific information for input to the policy process, and is not involved in politics or actual policy making.

IGBP's Organizational Relationships

Governing bodies: Secretariat, Executive Committee, and Scientific Committee

Complex network of relationships which helps leverage resources and expertise

Eleven Program Elements

- 8 discipline-oriented Core Projects based on key science questions**
- 3 Framework Activities facilitate the support and integration of Core Project research**

National science programs use the IGBP framework

RAND

IGBP's governing structure consists of a Secretariat, an Executive Secretary, and a Scientific Committee. The Secretariat coordinates the central activities of the program, raises funds, publicizes the organization's research, has a staff of nine people, and reports to the Executive Director. The Secretariat also answers to the IGBP Scientific Committee, which provides scientific guidance. The Secretariat is located at the Royal Swedish Academy of Sciences.

IGBP consists of a complex network of relationships of different organizations that effectively leverages resources and provides coordination for the scientific research. At the heart of the organization are eleven component program elements, consisting of eleven different activities and organizations, called core projects and framework activities. Each of these eleven organizations has its own office, staff, and implementation plans. These offices are spread throughout the US, Europe and Australia.

IGBP has eight discipline-oriented projects based on key questions related to the organization's mission. These eight Core projects are:

- Biospheric Aspects of the Hydrological Cycle (BAHC)
- Global Change and Terrestrial Ecosystems (GCTE)
- Global Ocean Ecosystem Dynamics (GLOBEC)
- International Global Atmospheric Chemistry (IGAC)
- Joint Global Ocean Flux Study (JGOFS)

Land-Ocean Interactions in the Coastal Zone (LOICZ)

Land-Use and Land-Cover Change (LUCC)

Past Global Changes (PAGES)

Planning and implementation for each of these projects is directed by a Scientific Steering Committee.

In addition, IGBP has three framework activities on data, modeling, and regional research that help support and integrate the scientific results into a holistic picture. These three activities are:

Data and Information Services (IGBP-DIS)

Global Analysis, Integration and Modeling (GAIM)

Global Change SysTem for Analysis, Research, and Training (START)

These framework activities are each guided by a Scientific Steering Committee or a Task Force.

IGBP as a whole and each of these various organizations have developed numerous synergies and relationships with other organizations, including the WMO, IPCC, the International Human Dimensions Programme (IHDP) on Global Environmental Changes, the World Climate Research Programme, UNESCO, and the UNEP.

In addition, this IGBP framework is widely used in national science programs throughout the world to set priorities in the scientific problems approached, to establish consistency in the methods used, and to achieve data compatibility.

IGBP's START Project

Global Change SysTem for Analysis, Research and Training (START)

- Mission is to develop a system of regional networks of collaborating scientists and institutions
- Co-sponsored by IGBP, IHDP, and WCRP

Regional Networks

- Started in Africa, Asia, and Mediterranean
- Build on existing regional networks
- Consist of a collaboration of regional and local institutions and leaders
- Include regional centers
- Customize activities for regional needs

RAND

To better understand the IGBP's activities and relevance to GSDI, we focused on one of the program elements that is most appropriate for GSDI's needs – the START organization. The Global Change SysTem for Analysis, Research, and Training (START) initiative was established in 1992 to help create a system of regional networks, with an emphasis on developing countries, to promote regional global change science and to enhance the research capacity of individuals, institutions, and the developing regions. START is co-sponsored by the IGBP, the IHDP and the WCRP.

The START mission is:

"To develop a system of regional networks of collaborating scientists and institutions:

- to conduct research on regional aspects of global change
- to assess the causes and impacts of regional global change,
- and to provide relevant information to policy makers and governments."²⁸

The organization has made significant advances in meeting this mission by its achievements in the facilitation of collaborative and multi-disciplinary regional research and related capacity building.

²⁸ From web site at: http://www.start.org/About/about_start.html

START builds on existing organizations activities and developed its own regional focus and networks where there was the most need. Thereby, the organization began by focusing on six regional networks in North Africa, Southern Africa, South Asia, Southeast Asia, Temperate East Asia, and the Mediterranean. Since then regional activities have begun in other areas, such as Oceania, Eastern Europe, and the Arctic. START works in close partnerships with other existing regional global change organizations, including the Inter-American Institute for Global Change Research (IAI), the Asia-Pacific Network for Global Change Research (APN), and the European Network for Research in Global Change (ENRICH).

Successful collaboration of institutions and individuals in a region is at the heart of the START regional networks. Each regional network has worked hard to engage the relevant scientific and technical leaders and institutions within their activities. Identifying such leaders, meeting with them, and building consensus so that everyone recognized the importance of participation, including relationships between global, regional and local interests, was the start of this process. The regional networks were able to generate interest at preliminary meetings and then developed implementation strategies with specific measurable tasks. Developing a good communication strategy was also an important part of this process. Being on the ground in the region also has been important; each START regional network includes a regional center with regional coordinating Secretariats, and affiliated institutions that include regional research nodes and sites.

Another important part of each regional network is the customization of activities for regional needs. Each regional center works with regional leaders and institutions to develop activities, strategic plans, and implementation plans that are appropriate for the region's needs. A strategy for sustaining the effort is also built into the implementation. Developing specific projects which have tangible outcomes and that local people participate in is a key part of developing the regional network and building capacity in the region. Such projects range in size and scope, such as a single workshop vs. a several year research project, and a technical training seminar vs. a scientific study. An example of a short-term technical project was the Pan African Start Committee (PACOM) that helped with a GIS and remotes sensing training and educational workshop in Mozambique in July 2000.²⁹ An example of longer-term science project is the

²⁹ For more information on this workshop and other projects by this regional network see Odada, Eric O., and Daniel O. Olago, "Pan African Start Committee (PACOM): Annual Report 2000/2001."

Southeast Asian Regional Committee for START (SARCS) that is conducting an integrated study on the relationships between sustainable development and global change feedback in Southeast Asia.³⁰

Some START activities are implemented across region networks because of common needs. The START Fellowship/Visiting Scientist Program and the START Guest Lecturer Program are examples of such cross-cutting activities. These programs have drawn applications from more than 200 developing country scientists and helped build capacity throughout the world. For instance, these programs have played a key role in the development of the Miombo project in Africa, and the development of a regional climate system model in Temperate East Asia.

START has a Secretariat with a few staff located in Washington, DC.

³⁰ For more information on this activity see Lebel, Loius, and Will Steffen, editors, "Global Environmental Change and Sustainable Development in Southeast Asia: Science Plan for a SARCS Integrated Study," 1998.

START Resources and Benefits

Many different funding partners

- National governments
- International aid, development assistance, and UN agencies
- Foundations

Proposal writing key to financial support

Regional Networks help to

- Mobilize scientific manpower and resources
- Promote regional cooperation in research
- Develop coherence and greater efficiency among global, regional and national research agendas
- Build capacity

RAND

START is very effective at leveraging resources from many different sources, including national governments, international aid sources, UN and other international sources, foundations, etc. The START operating budget is organized into three categories: core, project, and program budgets. The core budget provides support for administrative and operational costs of the Secretariat, and partial support to regional coordinating Secretariats, which are mostly support by host nations. The project budget support specific activities and projects that last a few months to several years. Such fund come from national funding agencies, cooperative research program organizations, foundations and international organizations. The program budget provides funding for long-term regional enabling activities that are described in the START implementation plan. Such activities are often sponsored by consortium. For example, support for the START Fellowship/Visiting Scientist and Guest Lecturer Programs comes from a number of sources, including the Dutch and Danish governments, UNDP, and the U.S. Agency for International Development. To develop and maintain this budget, the START Secretariat staff spends a large amount of time writing proposals.³¹

³¹ For more information on the START budget see Fuchs, Roland, Hassan Virji, and Cory Fleming, editors, "START Implementation Plan 1997-2002," 1998. In fact, this document is a good model for GSDI to look at in terms of financial, strategic, and implementation planning.

Through its regional approach, START has helped create numerous benefits to IGBP, especially with capacity building in developing countries. The regional networks help mobilize the resources required to augment existing global change scientific capabilities and infrastructure, and help enhance scientific capacity by strengthening and connecting existing institutions, by training global change scientists and by providing them with improved access to data, and research results. This regional approach has also helped to enhance the exchange of research results and other information, and to develop coherence and greater efficiency among global, regional and national research agendas.

IGBP/START Lessons Learned

Develop early consensus

Leverage funds from different sources

Use regional approaches, especially for developing country needs

- Adapt to regional and local needs
- Identify and engage regional and local leaders

Facilitate training and education

Focus on applications, an important driver for interest and capacity building

Provide a good communication structure

RAND

The IGBP has a number of similarities to the GSDI, including being global, using geospatial information, and facilitating an information driven collaboration process, and dependent on regional networks. In fact, the START initiative's regional networks that focus on developing countries offer some very relevant lessons given GSDI needs. There are some differences since IGBP and START are focused on scientific issues and scientists. However, their scientists are very much dependent on technical skills, especially geospatial ones, like the ability to use GIS and analyze, integrate, and share geospatial datasets. Thereby, the broader IGBP and the more specific START organization both provide important lessons for GSDI.

First, GSDI should develop consensus and engage all relevant participants worldwide in this process from the beginning to develop a globally recognized organization. Both IGBP and START are based on a developing and maintaining a consensus based process.

Second, GSDI should leverage funds from many different sources. Creative, persistent, and diverse approaches to finding and maintaining financial support are employed by both IGBP and START. Financial sources can include national governments, international aid sources, UN and other international sources, and foundations. Developing partnerships with existing organizations as much as possible is extremely important. In fact, given IGBP's needs and interests in GIS and geospatial data training and capacity building, GSDI should consider partnering with IGBP and trying to leverage off some of IGBP's activities. GSDI

should develop a financial plan and write many collaborate proposals; START offers a good model for such activities.

Third, GSDI should employ regional approaches, especially for developing country needs. Activities need to be adapted for differences in regional and local needs. In developing countries such needs often relate to basic development of infrastructure and skills. Approaches may need to be adapted for different technical infrastructure. For instance, in one South Asian country, scientists could not afford access to the Internet because of high communication expenses, so START helped to find the funding for their Internet connectivity so the scientists could send and receive e-mail. START also distributes geospatial data by CD's because it is too expensive for these scientists to share large geospatial data through the Internet. Part of this process is identifying and engaging regional and local leaders who can become the champions for the program. Such leaders were instrumental in START's success.

Fourth, again because of developing country needs for capacity building, GSDI should help facilitate training and education. Many different activities can and should be employed to help deal with the technical knowledge needs, and they should focus on long-lasting initiatives that lead to capacity building. The START Fellowship/Visiting Scientist Program is an example of one approach. Another example: START has a competitive process to grant awards to young scientists from Asia and Africa based on a peer-reviewed paper.

Fifth, GSDI should also focus on applications, an important driver for interest and capacity building. START has learned that the best way to build scientific capacity is to engage local scientists in specific research projects. By involving developing country scientists in international cooperative research projects they develop expertise, can experience the tangible results, and understand the benefits of participation first hand. Then those scientists become program supporters and spread by word of mouth the benefits of participation to their colleagues. Such projects should include specific tasks and measuring of progress.

Last, GSDI should provide a good communication structure. IGBP and START learned that global collaboration requires regular modality for exchanging information which is more than just e-mail. Face-to-face and verbal communication also needs to be part of this process.

World Meteorological Organization (WMO)

Coordinates global scientific activity for prompt and accurate weather and climate information

Main purpose is to facilitate and promote

- International cooperation for establishing networks of meteorological, hydrological, ocean and other observation stations
- Rapid exchange of meteorological information
- Standardization of meteorological observations
- Uniform publication of observations and statistics

Originally independent organization, now specialized agency of the United Nations

RAND

The World Meteorological Organization (WMO)³² is a highly structured organization with a long successful history in meteorological data collaboration. The WMO coordinates global scientific activity among governments to facilitate prompt and accurate meteorological information and other services for public, private and commercial use, including international airline and shipping industries.

"The purposes of WMO are to facilitate international cooperation in the establishment of networks of stations for making meteorological, hydrological and other observations; and to promote the rapid exchange of meteorological information, the standardization of meteorological observations and the uniform publication of observations and statistics. It also furthers the application of meteorology to aviation, shipping, water problems, agriculture and other human activities, promotes operational hydrology and encourages research and training in meteorology."³³

The World Meteorological Convention, by which the World Meteorological Organization was created, was adopted by the International Meteorological Organization (IMO) in 1947. The WMO commenced operations as the successor to IMO in 1951 and, later that year, became a specialized agency of the United

³² For more information on the WMO see the organization's home page at <http://www.wmo.ch/index.html>

³³ "Basic Facts about WMO," at <http://www.wmo.ch/web-en/wmofact.html>

Nations by an agreement between the UN and WMO. Within the United Nations, WMO provides the scientific voice on the state and behavior of the Earth's atmosphere and climate.

Currently, the WMO has about 185 members, comprising 179 Member States and six Member Territories, all of which maintain their own meteorological and hydrological services.

Over the years the WMO has established partnerships and close working relationships with many other organizations. As a United Nations Agency, WMO has close ties with the Food and Agricultural Organization (for climate data related to food production), United Nations Environment Program (in assessing climate change in particular), the International Civil Aviation Organization (for aviation-related meteorological information), the International Maritime Organization (for meteorological data for maritime application), and the International Hydrological Bureau (for hydrology-related meteorological data). WMO also works with the International Telecommunications Union and the International Organization for Standards (ISO) in setting standards for observation and data communication. WMO also partners with the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and its Intergovernmental Oceanographic Commission.

WMO Organizational Structure

World Meteorological Congress

- Determines policies, approves the program and budget, and adopts regulations

36 member Executive Council

- Supervises the implementation of resolutions and regulations for the Congress
- Advises members on technical matters

8 technical commissions

6 regional associations

Secretariat

- Serves as the WMO administrative, documentation and information center
- Headed by the Secretary-General of WMO

RAND

The World Meteorological Congress, which meets every four years, is the supreme body of WMO. This Congress determines policies, approves the program and budget, and adopts regulations. For instance, the WMO Congress adopts new standards (e.g., codes for reporting climatic data) and new technologies, but only when there is sufficient assurance that members will have the necessary hardware, software and technical capacity to implement them.

The Executive Council is composed of thirty-six members, including the President and three Vice-Presidents. It meets at least every year to prepare studies and recommendations for Congress, to supervise the implementation of Congress resolutions and regulations, and to advise Members on technical matters.

The Geneva-based Secretariat serves as the WMO administrative, documentation and information center and is headed by the Secretary-General of WMO. The Secretariat prepares, edits, produces and distributes the publications of the Organization and hosts secretariats of various WMO programs and sponsored activities, such as the IPCC.

The WMO has eight technical commissions responsible for: aeronautical meteorology; agricultural meteorology; atmospheric sciences; basic systems; climatology; hydrology; instruments and methods of observation; and marine meteorology. These technical commissions provide oversight of programmatic

structure and recommend scientific and technical standards for WMO activities. Each of them meets every four years.

Members are grouped in six regional associations to coordinate meteorological and operational hydrological activities within their region and to examine questions referred to them by the Council. The regional associations also meet every four years and are for: Africa, Asia, South America, North and Central America, South-West Pacific, and Europe.

The Presidents of the regional associations and technical commissions meet twice a year on the implementation of WMO resolutions and WMO programmatic activities. These meetings facilitate consultation between policy makers and technical experts.

The WMO conducts long -term planning covering ten-year periods to give framework, guidance and benchmarks to WMO and national, regional and international activities of members. These plans are consecutive, overlapping, and reviewed and revised every 4 years at the WMO Congress. The 5th Long-term Plan covers 2000 to 2009 and is scheduled for review and revision in 2003.

In the beginning of this plan, specific examples of the economic benefits from weather services is presented for some individual countries.

WMO's Operations

Major programs include

- World Weather Watch
- World Climate Programme
- Applications of Meteorology Programme
- Hydrology and Water Resources Programme
- Technical Cooperation Programme
- Education and Training Programme
- The WMO Regional Programme

Funding sources evolving

- Mostly from members for national observation systems
- More emphasis on multilateral development banks, private sector, and foundations

RAND

WMO has many different activities, but it focuses on the scientific and technical aspects of meteorological data and information, and does not advocate policy. The operation of national observing, communication and data-processing systems are planned and implemented within the WMO framework, and the WMO depends on these national systems for data.

WMO activities are organized under major programs, including:

- World Weather Watch
- World Climate Programme
- Atmospheric Research and Environment Programme
- Applications of Meteorology Programme
- Hydrology and Water Resources Programme
- Education and Training Programme
- Technical Cooperation Programme
- The WMO Regional Programme

WMO has no enforcement authority. Since global participation is necessary, it encourages and enables participation through outreach activities to Members and working through existing national, regional and international mechanisms to build capacity and promote cooperation.

Most WMO funding comes from members' own resources, committed to the operation of national systems. These resources are not part of the WMO regular

or extra-budgetary funds but they are planned and implemented within the WMO framework. Budget for the 2000 to 2004 period is set at a maximum of CFR (Swiss francs) 252.3 million (US \$144.6 million) from the regular budget and CFR 110.5 million (US \$63.3 million) from extra-budgetary sources. The regular budget comes from contributions of members (based on indicative scale used by all United Nations agencies). The extra-budgetary resources support specific components of programs, such as technical cooperation, education and training, and improvement of the World Weather Watch. The actual assessments (i.e. approximately 60M Swiss Francs per year) paid to WMO by members is used for program support, and that implementation costs of programs on data collection, exchange, etc. is provided "in kind" from members and is estimated at about 10 billion (US dollars) per year. In addition there are resources provided directly to WMO and indirectly in bilateral aid for development of meteorology in developing countries. Continuing decline in regular budget prompts the WMO to give special attention to mobilizing resources from other sources, such as multilateral development banks, the private sector, and foundations.

WMO Focuses on Members Needs

WMO assists members in the acquisition of appropriate technology and knowledge

- Especially important for developing countries
- WMO helps match donors and recipients

Technical Cooperation Programme facilitates and assists in

- The systematic transfer of meteorological and hydrological information
- Members obtaining technical expertise and equipment

Education and Training Programme helps organize and facilitate

- Special courses, conferences, and training programs
- Establishment and improvement of regional training centers

Regional Programme supports regional activities

RAND

The WMO focuses on meeting member needs, especially developing country needs. Before a new standard or technology is implemented, WMO works to ensure that members have the hardware, software, and technical capacity to implement them. For example, in the mid-1980s, WMO coordinated the donation of microcomputers for data processing to many developing countries as computers became essential to the transmission and interpretation of telecommunications transmission codes used for communicating meteorological data. The introduction of digital satellites in the next several years will require new receivers for many developing countries. WMO is working to encourage donations of equipment and training to cover countries and territories in all regions. Past experience saw U.S. assistance covering the Americas; Japan, for Asia; and Europe, for Africa. Dissolution of the Communist bloc in Eastern Europe and collapse of the Soviet Union will likely require additional assistance for countries in this region.

The WMO serves as a match-maker between donors and recipients, such as in a special activity called the Voluntary Cooperation Programme. This activity channels bilateral and multilateral assistance of donor countries (about \$10-12 million/year) for technology transfer and training activities. These funds do not cover overhead costs for WMO; every dollar goes directly from donor to recipient. WMO solicits requests for assistance from regional associations and individual members, communicates these requests to donors in an annual donor

meeting where funds are earmarked for specific activities. WMO also publishes a newsletter to update donors and recipients of areas in need of assistance.

Programmatic activities work individually and jointly to aid members in implementing standards and methodology in observation, e.g., in equipment transfer and training.

The Technical Cooperation Programme tries to bridge the gap between developed and developing countries by the systematic transfer of meteorological and hydrological knowledge and information. This program assists member countries in obtaining the technical expertise and equipment for the development of their national meteorological and hydrological services. In such capacity building activities, WMO works with major international partners such as the United Nations Development Programme, UNEP, the Global Environment Facility and regional development banks.

The Education and Training Programme organizes and facilitates the exchange of scientific knowledge through special courses, seminars, and training materials. Several hundred specialists take advanced courses each year because of this program. Other program activities include surveys of personnel training requirements, the development of training programs, and the establishment and improvement of regional training centers. Regular budget and extra-budgetary sources are both used for such training and education activities.

The Regional Programme provides the necessary support to the regional associations for the implementation of WMO programs and other activities that have a regional focus. The support is provided through three regional Offices and two Sub-regional Offices.

WMO Lessons Learned for GSDI

Provide a narrow and well defined focus

Focus on developing country needs

Provide regional approaches to

- Address training and maintenance differences
- Build capacity

Allow flexibility so organization can evolve over time and respond to different needs

Leverage partnerships

- Increase visibility and influence in international activities
- Important for financial support

Balance public good data needs with intellectual property rights and competition concerns

RAND

WMO has some important similarities with GSDI, including being global in scope, focusing on geospatial data, and helping facilitate geospatial collaboration. Also, WMO is dependent on regional and individual nation activities. This collaboration is slightly different from GSDI since it is focused more on a physical data product, and develops its own standards. In addition, the benefit from the data sharing is more obvious than with GSDI because weather data serves an important safety function. However, even the WMO makes sure it stresses the economic benefits from weather data.

Being a very large organization with parts of the organization having features similar to GSDI and having a long operational history, over 50 years, this international collaboration offers important lessons learned for the GSDI collaboration.

First, WMO experience shows that having a narrow and well defined focus keeps the organization focused so it can accomplish its mission.

Second, GSDI needs to focus activities on developing countries' needs so these countries can find resources to participate in national, regional, and global SDI activities. Such countries often do not have the financial resources, physical systems (computers, software, satellites, etc.) nor technical skills needed to collect, process, maintain, manage, and share geospatial data, such as weather information. The WMO focused numerous activities on developing countries to help them acquire needed hardware, software, technical skills and other

technologies and knowledge needed to operate and maintain their national systems. Many different mechanisms can be employed to facilitate technology transfer and training from developed countries and other sources to the developing countries. For instance, the WMO published developing country needs in a newsletter; helped matched donors who were offering assistance with appropriate recipients; organized training classes, seminars and materials; and helped establish training programs and regional training centers.

Third, regional approaches are needed to address training and maintenance differences in different parts of the world and to more effectively build capacity for SDI activities. WMO focuses on the unique needs of regions by having regional associations throughout the world. Being on the ground in different parts of the world is critical to global participation.

Fourth, allowing flexibility within the GSDI's operations and even its structure, is important so it can adapt to future changes, such as technology ones. The WMO's activities, funding sources, and technologies have adapted over the decades to better meet its mission given evolving cultures, societies, funding patterns, and technologies. Even the structure evolved as the organization became part of the UN. Even though the WMO is a highly structured organization it allows for flexibility within the system so it can adapt over time and respond to different needs and changes.

Fifth, GSDI should leverage partnerships and use existing mechanisms at all levels to increase "buy-in" or sense of ownership in the organization's work and mission. Partnerships also help to avoid redundancy, increase visibility, and increase influence in international activities. Such collaboration provides a response to the continuing decline in public funds for international activities. WMO effectively leverages partnerships with many different organizations as illustrated earlier.

Last, to address different cultural and data policy views, GSDI needs to balance public good data needs with intellectual property rights and competition concerns. The WMO has worked hard to balance providing climate data as a public good with intellectual property rights and competition concerns, as illustrated by WMO resolution 40. Resolution 40 was the result of a decade-long dispute over the commercial sale of meteorological data by national weather services and private firms. Under the WMO's World Weather Watch Programme, all Members of the WMO send meteorological data to regional and global data processing centers for sharing with other countries. No fees are charged or paid in these exchanges. Governments, which receive this information usually through their National Meteorological Service, can share all

of this data, including those parts restricted from re-export, with domestic users (e.g., industry, academics, researchers, planners). A dispute arose in the mid-1980s when some national weather services began selling climate assessments or other value-added services and products to local users. Some members complain that it is not fair to use what is free information and given in the spirit of sharing to make profits. The dispute exacerbated when private firms in some countries began commercial sale of value-added meteorological products and services to local and foreign buyers, including users in the country where the raw data originated. Resolution 40 settled this conflict by dictating that a country (or its private firms) can commercially sell value-added products and services only in its domestic market. Commercial sales of valued-added products and services in the country where the raw data originated is prohibited. An exception is possible only when there is approval from the country where the raw data originated. More recently, the Executive Council decided that commercial sales of specifically identified value-added products and services based on raw data from one country to a third country is also not acceptable.

Intergovernmental Panel on Climate Change (IPCC)

Purpose

- To assess scientific, technical and socio-economic information to understand the risk of human-induced climate change

Conducts assessments

- Based on published and peer reviewed scientific technical literature
- Does not carry out new research nor any monitoring

WMO and UNEP established in 1988

- Open to all members of the UNEP and WMO

RAND

The Intergovernmental Panel on Climate Change (IPCC)³⁴ is an international intergovernmental organization. IPCC assesses scientific, technical and socioeconomic information to understand the risk of human-induced climate change. The World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) jointly established the IPCC in 1988. Participation in IPCC activities is open to all members of the UNEP and WMO.

The IPCC conducts assessments of climate change science based on published and peer reviewed scientific and technical literature. This organization does not carry out any new research, does not make any policy recommendations, and does not monitor any climate related data. Producing assessment reports once every five years is the IPCC's core task. IPCC assessment reports have been highly influential in international discussion on climate change. The Third Assessment Report was approved April 2001. The Third Assessment Report allowed greater use of pre-publication and non-peer-reviewed scientific literature in consideration of different review processes used by those outside academia, e.g., government and industry publications, and the time lag involved in publication, in order to expand developing country participation. Assessment reports are built on working group reports. All IPCC reports must receive formal endorsement to be made official and then must be made publicly available.

³⁴ For more information on this organization see the IPCC home page:
<http://www.unep.ch/ipcc/>

IPCC Organization and Responsibilities

Actual Panel meets in yearly plenary

- Decides principles and procedures, work plans, and the budget
- Structures and approves reports

3 working groups, with separate tasks

- Assess the scientific aspects
- Address the vulnerability of systems and consequences of climate change, and options for adapting to it
- Assess options for limiting greenhouse gas emissions and mitigating climate change

Task Force on National Greenhouse Gas Inventories (NGGI)

- Oversees the NGGI Programme

RAND

The IPCC has a Secretariat, Chairman and Bureau to help run the organization. The Secretariat is responsible for organizing all IPCC meetings. The Panel meets in plenary sessions annually. The IPCC decides on the organization's principles and procedures, work plans of the working groups, the structure and outlines of reports, and the budget. Accepting and approving IPCC reports and electing the IPCC Chairman and the Bureau are other functions of the IPCC.

Three working groups perform the IPCC assessments. Working Group I assesses the state of climate science. Working Group II addresses the impacts of climate change, and options for adapting to it. Working Group III assesses options for limiting greenhouse gas emissions and otherwise mitigating climate change. The working groups and the task force are each co-chaired by a representative from both a developed and developing country.

These three working groups coordinate the production of working group reports and other special reports. Special reports are produced by the working groups in response to requests from the United Nations Framework Convention on Climate Change (UNFCCC). Both types of reports are assessments of state-of-the-art knowledge about different aspects of climate change. Coordinating authors selected for each working group report and special report recruit lead authors to produce draft reports. Draft reports usually go through three rounds of review before receiving official approval.

IPCC also has a Task Force on National Greenhouse Gas Inventories to oversee the National Greenhouse Gas Inventories Programme.

IPCC Financial Issues

IPCC depends on scientists' voluntary contributions for majority of the work

Funding from

- UNEP, WMO, and Parties to the UNFCCC
- Developed country co-chairs of Working Groups and Task Force for staff support and report production

Allocation of the budget for

- Travel support for developing country authors and officials participation (almost 50% of the budget)
- Organization of meetings
- Salaries of the Secretariat

RAND

IPCC depends on scientists' voluntary contributions of their time and research for the majority of the assessment work. These volunteers are the authors and reviewers of IPCC reports. These scientists volunteer for a number of reasons, because of the prestige associated with being involved in this highly regarded process, because of persuasion by peers, and because of the learning and networking opportunities.

IPCC funding comes from two main sources. First, an IPCC Trust Fund receives annual cash contributions from UNEP and WMO and from Parties to the UNFCCC. For contributions from individual countries that are Parties to the UNFCCC, an indicative scale dictates that no single country contributes more than 25 percent of the total and a less-developed country contributes no more than 0.01 percent of the total.³⁵ Second, developed country co-chairs of working groups and the task force pay for staff support and the production of working group reports and special reports.

Nearly half of annual IPCC budget goes to travel support for authors and officials from developing countries to participate in activities organized by the IPCC. The rest of the budget pays for the salaries of Secretariat (less than 10 full-time staff) and the organization of IPCC meetings.

³⁵ See "IPCC Principles and Procedures" at
<http://www.ipcc.ch/about/procd.htm>

IPCC Outreach to Developing Countries

Working Groups and Task Force are co-chaired by a developing and developed country

- Increases developing country participation
- Helps facilitate capacity building

Special travel support given to developing country authors and officials to attend

- Author meetings
- Workshops
- Annual Plenary

Encourages regional cooperation in greenhouse emissions inventory activities

RAND

IPCC has special activities to engage developing countries' participation in the organization's assessment activities. As already mentioned the working groups and task force are co-chaired by a developing and developed country, which helps increase developing countries participation and helps facilitate capacity building. Special travel support is given to authors and officials from developing countries to attend IPCC organized events, including the Plenary, workshops, and meetings for authors of IPCC reports. The provision of such travel funds also increases participation by developing countries. To engage developing countries, IPCC also encourages regional cooperation in greenhouse emissions inventory building to increase relevance of the information to its providers.

IPCC Lessons Learned for GSDI

Organizational structure needs to be flexible and have balance for participation by

- Top-down collaboration through formal structure
- Bottom-up collaboration of individuals

Champions are critical

Personal relationships are essential for building professional partnerships

Transparency and open process key

- Builds ownership and participation
- Increases credibility of the organization

Need to implement special outreach and procedures for developing countries

RAND

The IPCC is similar to GSDI in that it is global, using geospatial information, facilitating an information driven collaboration process, and dependent on volunteers and motivated people from around the world to help complete its mission. However, the process is a scientific one and its participants are mostly scientists, though many are government scientists. Despite these differences it provides many relevant lessons for GSDI. It also provides a different and interesting model of international collaboration compared to many of the other cases, (like WMO and ICAO), because it has a fairly simple structure and relies heavily on personal communications and connections to complete its work.

The first lesson IPCC provides for the GSDI is that the organization structure needs to include flexibility to balance between top-down collaboration through and formal structure and bottom-up collaboration by motivated individuals. IPCC's success relies on both top-down and bottom-up scientific collaborations to help define problems and assess results.

Second, organizational champions and motivated organizers are critical throughout the life of an organization. IPCC has found that the enthusiasm and motivation of individual scientists are critical to its operations, especially since it depends so much on volunteers.

Third, personal relationships are essential to building professional partnerships. IPCC relies on individual scientists communicating with their colleagues

throughout the world to develop the relationships needed to perform its assessments and elicit needed resources.

Fourth, to increase participation in GSDI and develop and maintain a good reputation, the organization needs to have a transparent and open process. Transparency and open process in review and dissemination of IPCC assessments builds ownership and broadens the understanding of this broad-scaled and complex problem.

Last, GSDI needs to implement special outreach and procedures for developing countries. Appropriate mechanisms need to be developed and employed to help developing countries find resources and value in the organization's mission so they want to participate. IPCC's co-chair arrangements, travel fund support and regional greenhouse emission inventory activities all are all examples of such mechanisms.

Regional SDI Case Studies

- Environmental Information Systems (EIS)-Africa
- European Umbrella Organisation for Geographic Information (EUROGI)
- Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)
- Permanent Committee on SDI for the Americas (PC IDEA)

RAND

In our analysis we examined four regional SDI case studies that cover most of the globe. These organizations have not been in existence as long as most of the international case studies. They all are struggling with growing pains, but most show some initial signs or promise of success. Given their regional focuses and initial activities such organizations have a good understanding about the challenges and needs for SDI development and support in their unique regions and countries. Thereby, these cases offer useful insights to GSDI about SDI development needs and different approaches that GSDI may want to employ in the organization's activities.

EIS-Africa

Environmental Information Systems (EIS)-Africa created in 1999

- Non-profit, pan-African organization of geo-information practitioners and institutions
- Evolved from the ten-year old EIS Program

Mission

- Facilitate the strategic development and use of geo-information in environmental management and sustainable development in Africa

Membership open to all sectors

- 24 member countries, mostly sub-Saharan Africa
- Over 2,000 individuals and institutions

RAND

EIS-Africa³⁶ is a new non-profit, pan-African organization which has evolved from the ten-year old EIS Program, which was funded and supported by several donors and international development agencies including the World Bank, the Government of Norway, the U.S. Agency for International Development (USAID), the German Agency for Technical Cooperation (GTZ), and several United Nations agencies including the United Nations Development Program (UNDP), and the United Nations Environment Program (UNEP).

The mission of EIS-Africa is:

"To support the development of an Africa society where high quality environmental information is readily available and accessible to policy and decision-makers at all levels, in support of sustainable development."³⁷

Even though EIS-Africa seems to be more environmentally focused than geospatial data oriented it actually is a continent wide effort focused on developing an SDI for Africa. EIS-Africa hopes to play a leading role in facilitating the strategic development and use of geo-information in support of effective environmental management and sustainable development in Africa.

³⁶ For more information on EIS -Africa see: <http://www.eis-africa.org>

³⁷ "EIS -Africa, A Network for the Co-operative Management of Environmental Information," Prospectus, undated, available from Jacob Gyamfi-Aidoo, Executive Director of EIS-AFRICA.

Involvement in EIS-Africa is open to government agencies, industry, academics, and NGOs, though initial members came mostly from national mapping agencies. Currently, membership dues are not required to be part of the EIS-Africa network, but the payment of dues is required to be an official member of the organization. Membership of EIS-Africa confers certain rights, privileges, and obligations, of which only duly registered and paid up members can benefit or need to oblige. The EIS-Africa network consists of about 3,000 information managers, decision-makers and other professionals, as well as institutions in sub-Saharan Africa, which produce or use environmental information for a variety of purposes. The earlier EIS Program operated largely in sub-Saharan Africa; the new organization is reaching out to nations throughout the continent. It currently has 24 member countries, mostly in sub-Saharan Africa. Central and North Africa have their own EIS programs which have not yet become integrated into EIS-AFRICA, although efforts are being made to integrate such activities. EIS-Africa maintains a mailing list for this network, an "open community" of EIS/geo-information practitioners, and encourages everybody on the list to sign up as official members.

EIS-Africa Objectives and Purpose

Objectives include

- Promote practices to reduce transaction costs of using information
- Use partnerships to expand expertise and capacities in information management
- Serve as a pool of expertise and technical resources
- Assist the donor community and international agencies in African initiatives
- Facilitate professional recognition of African EIS practitioners
- Represent the African position and involvement in GSDI

Organization working to

- Develop common principles and practices
- Document and share best practices
- Provide a forum for information sharing

RAND

The objectives of EIS-AFRICA are concisely presented in its prospectus:

"Promote EIS (geo-information) as a critical element in the exploitation of natural and environmental resources for sustainable socio-economic development;

Promote practices which reduce the transaction costs involved in the use of information, including improved availability and access, the use of common standards, and the removal of administrative and legal constraints;

Expand, through partnerships, a critical mass of expertise and capacities in information management essential for enhancing the quality of sustainable development decision making in Africa;

Serve as a pool of expertise, technical resources, and a knowledge base for assisting African governments and civil society to meet their priority needs for information on the environment, natural resources, and sustainable development;

Assist the donor community and international agencies to engage African expertise in the implementation of their programmes and other initiatives in Africa;

Facilitate the exchange of information, and enhance the use of techniques and processes in policy analysis and decision-support;

Create opportunities for professional recognition of African EIS practitioners;

Represent the African position and involvement in the development of the Global Spatial Data Infrastructure (GSDI) and other similar initiatives."³⁸

EIS-AFRICA hopes to provide a common platform for different stakeholders to develop a unified approach for using EIS, spatial data, and emerging communication and information technologies, which will help facilitate the flow of information, knowledge, expertise, and ultimately, people and commerce. It plans to provide services in support of policy-level decision-making, emphasizing the spatial dimension to enrich the policy debate.

The organization is trying to develop a network-based institutional and technical framework for improving the flow and use of information in environmental management. Rather than focus on a technological solution, this framework emphasizes common strategies, policies, procedures, data management, and communication tools and networking mechanisms that ensure access to data. This framework is supported by geo-information technology, within a supportive data policy setting. This will allow for environmental and other geospatial data to be collected, integrated, shared, analyzed, and the resulting information and products to be disseminated and used in support of decision making at all levels. EIS-Africa works to develop common principles and practices for EIS development and application, and facilitates the coordination of national and international EIS programs. Documenting and sharing best practices, building on existing activities and partnering with other organizations are other parts of EIS-Africa's framework.

³⁸ Ibid.

EIS-Africa Structure and Activities

Governance

- Secretariat, elected board, and International Advisory Panel
- Supporting office in South Africa

Several years spent on capacity building

- Numerous workshops and conferences to exchange information and build network
- Madagascar, Tanzania, and Ghana have training units to address acute training needs

Other activities and functions include

- Play an advocacy role on the value of SDIs
- Create awareness about need for collaboration and common data standards

RAND

EIS-Africa officially incorporated as an international not-for-profit organization in August 2000. A board, elected by members, is the main governing body of EIS-Africa. This board, which meets annually, provides policy, operational guidance, program orientation; helps to mobilize resources for the organization; and conducts strategic reviews of the state of EIS and geo-information development in Africa. An International Advisory Panel provides advice and guidance to the Board from an international perspective; assists in maintaining relationships with potential donors, fund-raising; and represents the organization at the international level. Membership of this panel consists of experts on environment and sustainable development, and includes donor representatives. The organization has a Secretariat, hosted in South Africa, which provides operational support. A coordinator heads the Secretariat and is the legal representation of the organization.

Including the activities of its precursor organization, the EIS Program, EIS-Africa has already spent several years in building capacity for environmental and geospatial information within Africa. Numerous workshops and conferences have been held to exchange information, build partnerships, and develop a network of relationships throughout Africa. For instance, EIS-Africa has developed working relationships with the African Association for Remote Sensing of Environment (AARSE), the African Organisation for Cartography and Remote Sensing (AOCRS), the Committee on Development Information (CODI) of the United Nations Economic Commission for Africa (UNECA), and the

Economic Community of West Africa Countries (ECOWAS). Focusing on training, technical assistance, and educational activities has been and will continue to be another important part of this capacity building process. An example of such training is how Madagascar, Tanzania, and Ghana have implemented EIS training units to meet the acute and perennial need for trained personnel. Such capacity building activities will continue to be a central part of EIS-Africa's activities.

The organization has many other planned and on-going activities and functions which it will play in developing SDI and EIS activities in Africa. EIS-AFRICA has been playing an advocacy role on the value of spatial data infrastructure. The organization creates awareness about collaboration needs and encourages coordinated efforts on data standards and harmonization of data sets. Other planned activities include: facilitating access to key environmental data-sets for Africa; documenting experiences and lessons learned in EIS development in Africa; maintaining a Help Desk to provide advice and guidance to members and other stakeholders; publishing a quarterly newsletter; and proving a web site as a comprehensive one-stop center for the African geo-information community. Another activity oriented toward technical assistance is EIS-Africa plans to publish EIS Development Resource Packs to support countries in their development of effective environment information systems. Such packs will include training manuals, publications about best practices, EIS guidelines, and sources of technical expertise and information.

The support for such activities come from dedicated volunteers, leveraging partnerships, some limited country support (such as South Africa hosting the Secretariat), and donations from international aid organizations and other sources. EIS-AFRICA would like to become a self-sustaining organization through membership dues, but for the foreseeable future, it is likely to continue to be funded mostly through grants and partnerships.

EIS-Africa Implementation Issues

Visionary and experienced leadership important

Building and broadening the network

- Going beyond the government mapping agencies
- "Environment" in name, at times, makes it difficult to reach out to other areas/issues

Difficulty in convincing governments of the value of SDI because

- Bureaucratic interests often narrowly defined
- Regional collaboration is low priority

Successful SDI activities in Africa come from

- A network of field practitioners who value cooperation because of direct experience

RAND

EIS-Africa has an ambitious agenda and faces many implementation issues in trying to achieve its goals, especially given the needs of many developing countries in Africa. Visionary and experienced leadership is critical in helping the organization address such issues.

To achieve its goals EIS-Africa needs to continue to broaden its network of support, resources, and members. In building a community of interest around spatial data needs, EIS-Africa leaders recognize a need to go beyond the early constituency of the EIS Program which resided largely in government mapping agencies. While this constituency formed a core of practitioners, it tended to exclude many other government interests who ought to be have been involved in spatial data infrastructure matters. Because of its historical roots in the EIS Program, EIS-AFRICA continues to carry a close identification with environmental programs and applications. "Environment" in the name has become a limiting factor for the organization as it seeks to broaden its network to economic development, agriculture, transportation, telecommunications, and other areas of public policy. However, the organization is trying to address such issues.

The organization also has difficulties of convincing governments of the value of SDI within their own borders. It is even more difficult to persuade them of the value of cross-border data sharing and cooperation on common data policy issues. Often the bureaucratic interests are defined so narrowly and provincially, that the notion of regional cooperation appears to be a very low priority. To

address such issues, EIS-Africa sees the future of SDI in Africa being in building a network of field practitioners who clearly understand the value of cooperative activity through their own direct experience.

EIS-Africa Lessons for GSDI

Need to enlist help of individual champions and visionary leaders

Use on-the-ground experience as the driver

- Grassroots practitioners see value in personal project experience and then they convince their institutions to support spatial data activities
- Value of GSDI is made through highly concrete field applications

Facilitate capacity building in developing countries with regional and country

- Networks for training and infrastructure
- Workshops and best practices documents

RAND

EIS-Africa offers useful insights for GSDI activities in Africa and countries in other parts of the world, especially providing insights about developing country needs.

First, GSDI needs to find and employ enthusiastic and visionary individuals as champions in building SDIs at the national, regional and global levels. EIS-Africa has learned that building the support for SDI concepts and development comes from the dedication, enthusiasm, and hard work of such champions.

Second, GSDI need to use on-the-ground experience as a driver, especially in Africa. The future of EIS-AFRICA seems to be in individuals who through their own direct project experience come to realize the value of harmonizing data sets for development, increasing data accessibility, and developing a network of technical expertise. This is an important point for GSDI to recognize. At least for Africa, as appealing as the concept of GSDI might be in the abstract, it is unlikely to catch on as an on-going concern unless grassroots practitioners clearly see its value in their own personal project experience. These are the individuals who would then go to their supervisors, and then up through the bureaucratic chain, to get institutional support and funding. The value of GSDI must be made apparent through highly concrete field applications.

Last, GSDI must help facilitate the development of capacity building in developing countries to really address the regional and national needs for training and education, and for computer hardware and software and other

physical and intellectual infrastructure. Without such skills and resources many developing countries do not have the capabilities to participate, nor do they see the value. A core part of EIS-Africa's activities focuses on such capacity building. GSDI should also be sure to help facilitate the development and implementation of a range of capacity building mechanisms at the regional, sub-regional and national levels. EIS-Africa provides examples of such mechanisms including providing workshops, best practice documents, training centers, and educational materials. Developing a network of dedicated individuals and institutions as partners, communication channels, and supporters is a key part of such capacity building.

European Umbrella Organisation for Geographic Information (EUROGI)

Mission

- **Maximize the effective use of geographic information for the benefit of the citizen, good governance and commerce in Europe**
- **Represent the views of the geographic information community**

Association of associations

- **20 national associations**
- **1 pan-European sectoral organization**

Structure: Executive Committee, President, and General Board

RAND

EUROGI the European Umbrella Organisation for Geographic Information,³⁹ was set up in November 1993, as a result of a study commissioned by the European Commission to develop a unified European approach to the use of geographic technologies. The organization's mission is

"To maximise the effective use of geographic information for the benefit of the citizen, good governance and commerce in Europe and to represent the views of the geographic information community."⁴⁰

EUROGI's specific objectives are to

1. Encourage the greater use of geographic information throughout Europe
2. Raise awareness of the value of geographic technologies and information
3. Facilitate the development of national geographic information associations in all European countries
4. Facilitate the development of a European Spatial Data Infrastructure
5. Represent European interests in the GSDI

³⁹ For more information on EUROGI see the organization's web site at:
http://www.eurogi.org/welcome_new/welcome.html

⁴⁰ EUROGI web site: http://www.eurogi.org/welcome_new/welcome.html

EUROGI focuses on broader policy issues, while EuroGeographics, another European collaboration, focuses on standards and technology issues related to geographic information.⁴¹ EuroGeographics is a full member of EUORGI and they often collaborate in EC funded projects. EUORGI collaborates with many other regional and international organizations. However, it is independent of the United Nations, though it may work with UN groups on projects. EUORGI also has strong support from the European Union (EU), a political entity, which makes it different from other regional SDI's.

EUROGI is an association of associations with twenty-five members consisting of twenty-two national associations and three pan-European sectoral organization. A requirement of membership is that the organization has its registered office and headquarters in Europe, and that a majority of its members, or of its shareholders and/or its activities are based in Europe.

EUROGI is established as a European Foundation under Dutch law with its headquarters and Secretariat located in The Netherlands. The organization is governed by a President and an Executive Committee. The Executive Committee and Secretariat perform the day to day management of EUROGI. Only full members are represented in the General Board that elects the President and the Executive Committee. A Secretary General, appointed by the Executive Committee, performs executive and public relations tasks. There is one annual meeting for the General Board and three to four per year of the Executive Committee.

⁴¹ EuroGeographics consists of about 35 members from governments only. Member are from the official national mapping organizations in Europe. For more information see <http://www.eurogeographics.org/>

EUROGI Membership Issues

Provides different membership options

- **Full: National and Pan European organizations with voting rights**
- **Candidate: National organizations less dues, no voting rights**
- **Associate: Pan European organizations, including industry, no voting rights**

Emphasizes the benefits of joining, including

- **Access to the European Commission and community**
- **Learning and networking benefits**
- **Project participation opportunities**

RAND

EUROGI members belong to one of three categories: full, candidate and associate members. Full membership is open to national and Pan European organizations acting in the geographic information field at a European level. Full members have voting rights. From each European country, only one national organization is able to become a full member of EUROGI. Candidate membership is for national geographic information organizations which are considering EUROGI membership. A Candidate membership is valid for at most three years, after which time a decision must be made about joining EUROGI as a full member. Pan European organizations also have the option of becoming a temporary member. Associate members includes some industry associations. Candidate and associate membership dues are less, 20 % and 10% of full membership respectively. However, such memberships do not have voting rights.

EUROGI stresses the benefits of joining its organization in order to increase and maintain members, as well as resources. The document "Benefits to Being a EUROGI Member" is distributed and posted on the EUROGI web site.⁴² Benefits from membership include direct involvement with the European Commission; a forum to learn and network with other experts; a knowledge center for geographic information at the European level; a lobbyist organization; and the

⁴² The document "Benefits to Being a EUROGI Member" can be downloaded from EUROGI's web site at <http://www.eurogi.org/>.

ability to participate in EUROGI projects, that raise geographic information awareness.

EUROGI Activities and Funding

Activities focus on disseminating information

- Organizing workshops
- Writing documents
- Web site

Employs various strategies for financial support, including

- Membership dues
- Outside sources for special projects

Financial support is a constant challenge

RAND

Activities focus on information dissemination and diffusion to promote, stimulate, and support the development and use of geographic information and technology. EUROGI arranges numerous workshops for European networking and information exchange, such as data policy workshops. Providing publications is another important dissemination mechanism. EUROGI conducts and commissions various geographic information related studies which it publishes and makes available on its web site. EUROGI's web site contains extensive information on geographic information activities throughout Europe, such as a list of European Commission funded projects that involve geographic information and over 1000 names of European geographic information vendors, producers, users, and researchers (see the web site's GI people). Some of this information is accessible by members only, such as a list of European experts in various geographic information fields, including agriculture, land and mapping, standards, utilities, education and training, legal issues, and oceanography. EUROGI also has a project focused on developing an European Geographic Information strategy. This EU supported project is called the Geographic Information Network in Europe (GINIE) project.⁴³

Maintaining financial support is a constant challenge for EUROGI. The organization finds funding from a variety of sources. Members pay an annual membership fee that pays for the main operational expenses, such as the

⁴³ For more information on GINIE see the EUROGI web site, www.eurogi.org.

Secretariat. Special project funding comes from other sources, including the European Union. In fact, EU funded projects are an important source of funding for EUROGI activities.

EUROGI Lessons Learned

Build upon and harmonize with existing organization's activities

Focus on

- Dissemination and awareness
- Capacity building
- Building a reputation as being a useful organization to be part of

Stress the benefits of joining, such as providing benefits to membership document on the web

Conduct projects in application areas

RAND

EUROGI offers a number of lessons for GSDI development and implementation. First, build upon and harmonize with existing organizations' activities because this helps leverage resources and build a niche for the organization. Many different geographic information organizations, activities, and collaborations exist in Europe. EUROGI has worked hard to develop synergies and a good reputation with them, and to provide a unique resource to the geographic information community. Second, focus on geospatial information dissemination and awareness, and capacity building, which helps increase visibility, and can help with membership and financial support. Build a reputation as being a useful organization, especially as an information and resource provider. Even the fairly low-cost act of developing resource guides, such as "The SDI Cookbook"⁴⁴, and information materials on the web, such as EUROGI projects and people lists, can be very effective information dissemination mechanisms. Third, stress the benefits of active participation in the organization for membership and financial reasons. Distribute such information widely and post it on the web site. GSDI could develop a 'benefits to joining GSDI' document, as EUROGI did. Last, conduct some specific projects that focus on useful applications of geographic information. Such projects help make the benefits of SDI activities more concrete and real to participants, especially when they focus on economic or public policy areas that members care about. EUROGI's experts

⁴⁴ See Nebert, Douglas D., editor, "Developing Spatial Data Infrastructures: The SDI Cookbook," Version 1.0, GSDI, July 6, 2000.

list is an example of such an activity. Similarly, in June 2001 EUROGI held a workshop in Budapest, Hungry, on "Cadastral data as a component of spatial data infrastructure in support of agri-environmental programmes." Such projects need to be customized for the different needs and interests throughout the world, especially developing countries needs.

Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)

Goal: Maximize the economic, social and environmental benefits of geographic information by providing a forum for Asia and the Pacific nations to

- Cooperate in regional and global geographic information infrastructures and information sharing
- Participate in relevant education, training, and technology transfer

Membership

- Directorates of the national survey and mapping organizations
- 55 member nations

RAND

The Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)⁴⁵ was established in 1994 to help develop regional spatial data collaboration, development, and infrastructure in Asia and the Pacifics. As stated in their founding charter,

"The aims of the Committee are to maximize the economic, social and environmental benefits of geographic information in accordance with Agenda 21 by providing a forum for nations from Asia and the Pacific to:

- a. cooperate in the development of a regional geographic information infrastructure;
- b. contribute to the development of the global geographic information infrastructure;
- c. share experiences and consult on matters of common interest; and
- d. participate in any other form of activity such as education, training, and technology transfer."⁴⁶

⁴⁵ For more information on PCGIAP see the organization's web site at:
<http://www.gsi.go.jp/PCGIAP/>

⁴⁶ PCGIAP, "Permanent Committee on GIS Infrastructure for Asia and the Pacific STATUTES," April 22, 1999, available at
<http://www.gsi.go.jp/PCGIAP/pcstat.htm#a3>.

Directorates of the national survey and mapping organizations or equivalent national agencies of the nations from Asia and the Pacific are the official members of PCGIAP. The specific list of nations from the Asia and the Pacific region come from the United Nations. Each nation has one official voting representative to the Committee. Countries may nominate a number of additional persons as experts to attend meetings of the Committee. There are fifty-five permanent member nations, including: Afghanistan, American Samoa, Australia, Bangladesh, Burma, Cambodia, China, Fiji, French Polynesia, India, Indonesia, Iran, Japan, Kazakhstan, Korea North (Democratic People's Republic), Korea South (Republic of), Laos, Malaysia, Maldives, Mongolia, Nepal, New Zealand, Niue, Pakistan, Papua New Guinea, Philippines, Russian Federation, Singapore, Sri Lanka, Tajikistan, Thailand, Turkmenistan, Uzbekistan, and Vietnam.⁴⁷

However, currently less than a third of these are consistent active participants within the organization.

⁴⁷ For a full list of member nations see:
<http://www.gsi.go.jp/PCGIAP/pcmemb.htm>

PCGIAP Structure

An official UN Committee

Executive Board

- **President, Vice President, Secretary, and up to 7 other Members**
- **Plan and coordinate PCGIAP work**

Four working groups conduct a range of projects to promote and develop regional data and collaboration

- **Regional Geodesy**
- **Fundamental Data**
- **Cadastre**
- **Institutional Strengthening**

RAND

PCGIAP operates under the purview of the United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP) and submit reports and recommendations to that Conference. Thereby, the organization has a UN type of structure. PCGIAP is governed by an Executive Board consisting of a President, a Vice President, a Secretary, and up to seven other members. The Executive Board is elected by the Committee, serves for about three years, and is elected at the UNRCC-AP meeting. The Board meets twice a year while the entire PCGIAP meets once a year. Planning and coordinating PCGIAP work is the main function of the Executive Board. Other functions include: designing, monitoring and assessing the regional spatial data infrastructure; arranging and managing publications, promotional material, and the PCGIAP Internet site; coordinating funding proposals to aid agencies; and giving presentations to other related bodies, such as ISO TC211 and the GSDI Steering Committee.

Four working groups conduct a range of projects to promote and develop regional data and collaboration: Regional Geodesy, Fundamental Data, Cadastre, and Institutional Strengthening. The Regional Geodesy Group is working to establish a regional vertical geodetic datum, to enhance a regional geodetic infrastructure through annual cooperative campaigns, and to improve the regional geoid. This work group has a regional campaign to more effectively engage members in the group's activities. Geodetic technology transfer to Pacific Islands nations is another project of this group. The fundamental data working group conducts a range of activities including: a technical questionnaire on

fundamental data; a pilot project on an administrative boundary dataset; developing specifications and an implementation plan for regional fundamental datasets; and developing a specification and implementation plan for a regional spatial data clearinghouse with priority given to metadata, and data dictionary issues. The Cadastre work group is facilitating a discussion on marine cadastres; undertaking a study of land administration issues; and facilitating a workshop to develop a template for country profile analyses of cadastre and land administration information.

The Institutional Strengthening working group focuses on member involvement, education and training, and sub-regional program issues. This group is looking at ways to increase active participation by members, especially by trying to learn and address the needs of developing country members. This group is conducting a survey of regional education and training facilities, developing and maintaining an education and training information database for the region, and composing a glossary of spatial data infrastructure terms. Sub-regional activities have focused on workshops and collaboration for areas such as the Pacific Group and West Asia.

PCGIAP Focuses on Regional Collaboration and Data Development

Objectives include

- **Developing a regional geodetic framework, regional topographic datasets, national cadastral datasets and regional geographical names datasets**
- **Preparing guidelines and strategies to assist members in cadastral development for individual nation needs**
- **Helping find funding to support development needs of members and for the development of a regional spatial data infrastructure**
- **Looking at legislative and administrative procedures for acquiring and sharing spatial data**

Active in related global activities

RAND

PCGIAP focuses on regional collaboration and data development for spatial data. This emphasis is reflected in the objectives, which the organization is working to achieve:

- "a. To define the nature of a regional geographic information infrastructure that each country in the region can contribute to in order to meet regional and global mapping and GIS requirements.
- b. To determine the nature of legislative and administrative procedures and orders appropriate to the acquisition and sharing of spatial data.
- c. To develop a regional geodetic framework, regional topographic datasets, national cadastral datasets and regional geographical names datasets as the basis for regional GIS activity.
- d. To document the status of key geographic datasets and key agencies in each member nation, and develop a framework for the exchange of such information.
- e. To prepare guidelines and strategies to assist member nations for the implementation of cadastral development to meet individual member nation needs.
- f. To determine the need for research, training and technology and policy exchange in relation to the beneficial impact of geographic information on the social, economic and environmental objectives of member nations of Asia and the Pacific region.

g. To explore opportunities for aid funding to support development needs of member nations and for the development of a regional spatial data infrastructure.⁴⁸

As this last objective reflects, PCGIAP is working to establish a regional SDI called the Asia Pacific Spatial Data Infrastructure (APSDI).

Besides reporting to the UNRCC-AP the Committee also establishes links with other relevant United Nations programs, regional and international bodies, such as UNRCC for the Americas, the Permanent Committee on Spatial Data Infrastructure for the Americas (PC-IDEA), EUROGI, the International Steering Committee for Global Mapping (ISCGM), the GSDI Steering Committee, and the International Association for Geodesy (IAG).

⁴⁸ PCGIAP, "Permanent Committee on GIS Infrastructure for Asia and the Pacific STATUTES," April 22, 1999, available at <http://www.gsi.go.jp/PCGIAP/pcstat.htm#a3>.

PCGIAP Addressing Financial and Participation Issues

Employing diverse funding approaches

- **Members cover their own expenses**
- **Some developed countries provide travel funds for developing countries' members to participate in meetings**
- **Additional funding sought for special projects**

Stressing benefits to participation

- **Networking opportunity with neighbors**
- **Learning what is going on in the community**
- **Countries want to show they have expertise**

RAND

PCGIAP's two greatest challenges have been securing ongoing funding, and finding and maintaining active participation by member countries.

The organization employs diverse funding approaches to carry out its mission, and relies heavily on volunteer time from members. Members do not have to pay any membership dues, however, individual members pay their own meeting travel expenses and other costs of participation. The Secretariat's basic operating expenses are paid by the host country's government, so currently Japan provides this support. Some developed countries provide travel funds for meeting participation for developing countries' and other members who cannot find financial support. Australia, China, Iran, Japan, and Malaysia have all provided some financial support to help other nation's members travel to meetings. Additional funding is sought for special projects from other sources, such as national and international aid organizations.

To increase membership participation PCGIAP is taking a number of steps as already discussed, such as conducting a survey to better understand country needs and implementing regional approaches. PCGIAP also stresses the benefits to participation. Such benefits include: individual member country networking opportunity with neighbors on SDI issues; learning about what the latest developments are in the spatial data and technology community; and countries can prove to their neighbors that they have expertise and competence in this technical area. In addition, countries recognize how they are contributing to a regional spatial data infrastructure that benefits everyone.

PCGIAP Lessons Learned for GSDI

Employ regional approaches, helps to

- Increase participation
- Build cooperation and unity
- Overcome different cultural, language and legal differences

Need special outreach for developing countries, especially helping with

- Finding financial support
- Education and training

Find dedicated champions

Focus on some specific projects to show benefits and motivate participation

RAND

GSDI should employ regional approaches. PCGIAP found that regional and even sub-regional approaches are important to increase active participation by members. Focusing on some smaller areas for conferences and projects makes it easier for nations to participate because they do not have to travel as far and can see relationships to own country's interest more readily. In addition, with a smaller group it is easier to communicate and build cooperation and consensus on difficult issues and can help the collaboration overcome some of the cultural, language, and legal differences.

For regional and global SDI participation, special outreach is needed for developing countries. To increase developing countries active participation PCGIAP helps such countries find financial support, such as other countries providing some travel funds, and helps provide some education and training. Even providing basic information about SDI development can have a large impact for some countries which do not even know where to begin in developing a national spatial data infrastructure. For example, "The SDI Cookbook" developed by GSDI is a useful resource for countries that need some guidance on the process of setting up an SDI.

Finding dedicated individuals who are motivated and enthusiastic and willing to work for regional or global SDI development is very important. One long time member of PCGIAP noted how first contact with a nation was critical to getting active participation. When PCGIAP was able to find an enthusiastic individual

within a country and he or she started coming to meetings, it helped to build the active participation of that country in PCGIAP.

GSDI should focus on specific projects to show tangible accomplishments and benefits of participation, and to motivate additional participation in the collaboration. PCGIAP found that specific projects, such as its data framework development and administrative boundaries project help convince members of the benefits of participation in the organization. Just having a sub-regional conference for Pacific countries to help identify their SDI needs helped increased participation.

Permanent Committee on SDI for the Americas (PC IDEA)

Goal: Maximize the economic, social and environmental benefits of geographic information by providing a forum for nations to

- Cooperate in global and regional geographic information infrastructure development
- Share experiences and activities
- Participate in relevant education, training, and technology transfer

Evolved from the United Nations Regional Cartographic Conference for the Americas (UNRCC-Americas) committee

RAND

The Permanent Committee on Spatial Data Infrastructure for the Americas (PC IDEA)⁴⁹ is a regional SDI for the Americas. PC IDEA was established pursuant to resolution 3 of the 6th United Nations Regional Cartographic Conference for the Americas (UNRCC-Americas) in New York in 1997 and is part of the United Nations, operating as a committee under the purview of the UNRCC-Americas. The committee became an official operating organization in 2000. PC IDEA is modeled after the PCGIAP with similar goals and structure.

As stated in the PC IDEA Final Statutes, the aims of the Permanent Committee are in accordance with the principles of Agenda 21, with the purpose of maximizing the economic, social and environmental benefits as consequence of using spatial information; starting from knowledge and exchange of experiences and technologies from different countries, based on a common model of development, that allows the establishment of an Spatial data Infrastructure in the region

The objectives of the Committee are:

1. To establish and coordinate policies and technical norms for the development of the regional spatial data infrastructure for the Americas

⁴⁹ For more information on PC IDEA see the organization's web site at:
<http://www.cpidea.org.co/cpingles/Publicar/index.html>

2. To promote, with high-priority, the establishment and development of national spatial data infrastructures in each member country of the Permanent Committee.
3. To encourage the exchange of spatial information between all the members of the community of the Americas, acting with respect of its autonomy and according to its national laws and policies.
4. To promote the cooperation, research and the exchange of experiences in areas of knowledge related to spatial information matter.
5. To establish guidelines and strategies to assist member nations for the implementation of cadastral development to meet individual member nation needs.

PC IDEA Structure

Executive Board

- President, Vice President, Secretary, and up to 7 other Members
- Plan and coordinate PC IDEA work

Six working groups

- Legal and economic affairs
- Communications and SDI awareness
- Technical
- Cadastre
- Geographic names
- Institutional capacity building

Established links with relevant regional and global organizations

RAND

PC IDEA is governed by an Executive Board consisting of a President, a Vice President, a Secretary, and up to seven other members. The Executive Board is elected by the Committee, serves for about three years, and is elected at the UNRCC-Americas meeting. Planning and coordinating PC IDEA work is the main function of the Executive Board. Other functions include: designing, monitoring and assessing the regional spatial data infrastructure; arranging and managing publications and the PC IDEA Internet site; coordinating funding proposals to aid agencies; and submitting activity reports to the UNRCC-Americas.

Currently, PC IDEA has six working groups to help it carry out its objectives through the development and implementation of specific projects. The working groups are: Legal and economic affairs, Communications and SDI awareness, Technical affairs, Cadastre, Geographic names, and Institutional capacity building. The technical affairs group focuses on the development of policies and inter-institutional agreements, fundamental data sets, geographic information standards, and geospatial data clearinghouses. The Institutional capacity building work group is focused on increasing members' technical capacity by establishing technical and financial cooperation agreements based on members needs.

PC IDEA seeks to establish links with many other relevant regional and international organizations, including: the Economic Commission for Latin America, the Organization of American States, the Directorate of Geographic

Institutes of South America, the Sustainable Development Network, the International Steering Committee for Global Mapping, ISO TC 211, the United Nations Regional Cartographic Conference for Asia and the Pacific, and the GSDI Steering Committee.

PC IDEA Membership and Financial Issues

Membership issues

- Representatives of national organizations in charge of geographic information coordination are official voting members
- Nominated geospatial experts may attend the annual membership meetings
- 24 different nations

Financial support

- UN provides some administrative support
- Members pay for all travel expenses
- Host country pays for arranging meetings
- Members and others fund special projects

RAND

Directors or designated representatives of national organizations in charge of geographic information coordination are the official voting members in PC IDEA. If a country does not have such an organization then the representative may be appointed from the national mapping or surveying agency, or other relevant organization. Each nation can only have one official Representative to the Committee. However, nations may nominate a number of additional persons as experts to attend the annual membership meetings of PC IDEA. Currently twenty-four different nations are participating in the Committee. Active members include representatives from the following countries: Argentina, Mexico, Guatemala, Bolivia, Panama, Canada, Jamaica, Venezuela, Peru, Brazil, Honduras, Nicaragua, Costa Rica, Chile, El Salvador, Dominican Republic, Paraguay, Cuba, Belize, Guyana, Ecuador, Colombia, Uruguay, and the United States.

Financial support for PC IDEA comes from a variety of sources. The UN provides basic administrative support when the meeting is held along with the UNRCC-Americas meeting. The host country pays for arranging the Committee and Executive Board meetings. Expenses for the actual administration of the Committee and Executive Board are paid by individual members based on their respective responsibilities. Members pay for their own travel expenses when attending PC IDEA meetings. Members and other sponsors may provide financial support for special projects or objectives approved by the Committee.

PC IDEA Activities

Activities are focused on

- Institutional development
- Capacity building
- Communication and committee outreach

Specific projects have included

- Regional surveys
- Promotion of PC IDEA activities
- Creation and maintenance of the web site

Individual champions have lead on activities

Work groups are slowly progressing

RAND

In 18 months of operations, PC IDEA has not had much time to develop and implement many activities. Most of PC IDEA's activities so far have been focused on institutional development, capacity building, communication and committee outreach to build the organization and members' ability to participate. Establishing partnerships and on-going relationships with relevant and synergistic organizations, such as PCGIAP and GSDI, is another important part of the organization's activities.

Specific projects that are well underway include: the promotion of PC IDEA activities, the creation and maintenance of a thorough web site, and regional surveys. PC IDEA has already implemented two regional surveys. These surveys have helped the organization to identify key players in the community, to motivate them to become active in PC IDEA and understand specific regional and national needs and interests in developing SDIs and PC IDEA.

So far, PC IDEA activities have basically been the responsibility of enthusiastic and dedicated leaders who act as champions for PC IDEA. For instance, the Executive Secretariat has been in charge of the creation and maintenance of the web site, updating the list of members, and communication with members, among other key activities.

Longer term, the organization is working to develop more active working groups that will take on more responsibilities and projects. Implementation of working groups has not been an easy task. It is taking a while to implement these groups

as cohesive, active, and efficient work groups. However, the Legal and Economics Affairs work group has been quite active because of the need to advance the final version of the PC IDEA Statutes.

PC IDEA Lessons Learned

Need to account for multi-cultural, regional and local considerations

- Respect cultural and political differences
- Understand the unique conditions facing each region and country

Need to focus on developing countries

- Help with capacity building
- Fund specific short terms projects
- Stimulate national governments' interest in spatial data policy

Create a Web/Internet-based outreach strategy

Take advantage of other's relevant activities

RAND

Even though it is a fairly new organization, PC IDEA offers useful insights for GSDI in its development and implementation process based on PC IDEA's experiences in the Americas. First, GSDI needs to account for multi-cultural, regional, and local considerations in its activities. To succeed as a regional SDI, PC IDEA has learned that the organizational structure of its initiative must take into account multi-cultural considerations and realities. In addition, SDI work needs to be based on respect for cultural and political differences and the specific conditions facing each country. PC IDEA is addressing such concerns with the establishment of sub regional committees under the PC IDEA umbrella to help facilitate consensus, through its regional surveys, and with other sub-regional and local activities.

Second, GSDI needs to focus on developing countries to facilitate their involvement in national, regional, and global SDI activities. PC IDEA experience highlights three areas that are important for engaging developing countries participation in SDI activities: helping to build technical and intellectual capacity, funding short-term pilot projects that show the direct SDI benefits, and stimulating high level government interest in spatial data policy. National government interest is needed to help address data production, access, and IP issues, to build support for SDI participation, and to potentially reduce the impact of the digital gap.

Third, GSDI should create a well developed web-based and Internet-based strategy to improve communications and outreach, and to help expand

organizational support. For instance, PC IDEA has found that having a web-based strategy for communications and outreach has been very useful to motivate members to join and actively participate in the organization, and to improve member communications. Such a communications strategy has also been important for country members that can not afford to attend meetings.

Last, GSDI should build on the experiences of other organization's SDI and spatially oriented activities. There is no need for GSDI to re-invent the wheel. For instance, PC IDEA has been benefiting from other regional and national SDI established initiatives around the world. The experience from PCGIAP, EUROGI and several national SDI is proving of outstanding value. In addition, both formal and informal partnerships and information exchange relationships are an important part of this process.

A. Appendix: Brief List of All Cases

This appendix contains a list of every case study examined in this analysis, along with a web site for each case where the web address is known. The cases that were addressed more in depth, because of their relevance to GSDI, are explained more thoroughly in the main text. However, the others are listed here because of lessons learned from briefly examining them. For individual country SDI cases the web address may be for a lead organization developing the SDI or a site that describes the SDI activity because the SDI web site was not known or does not yet exist.

African Spatial Data Infrastructure Initiative, National Spatial Information Framework (NSIF), http://www.nsif.org.za/africasdi_main.htm

Argentina's SDI development
<http://www.spatial.maine.edu/~onsrud/gsdi/Argentina.html>

Association for Biodiversity Information (ABI) <http://www.abi.org/>

Australia New Zealand Land Information Council (ANZLIC)
<http://www.anzlic.org.au/index.html>

Australian Surveying and Land Information Group (AUSLIG) and the Australian Spatial Data Infrastructure (ASDI) <http://www.auslig.gov.au/new.htm#boost>

Bermuda's SDI development
http://www.spatial.maine.edu/~onsrud/GSDI_surveys/bermuda/bermuda_00.htm

Canadian Geospatial Data Infrastructure (CGDI) being developed by Canada's Interagency Committee for Geomatics (IACG),
<http://cgdi.gc.ca/english/index.html>

China's SDI development
http://www.spatial.maine.edu/~onsrud/GSDI_surveys/china_macau/china_survey00.htm

Colombia's SDI development, Instituto Geográfico Agustín Codazzi (IGAC)
<http://www.igac.gov.co/>

Cyprus's SDI development
<http://www.spatial.maine.edu/~onsrud/gsdi/Cyprus.html>

Environmental Information Systems - Africa (EIS-Africa) www.eis-africa.org
 (formerly at <http://www.grida.no/eis-ssa/>)

EuroGeographics <http://www.eurogeographics.org/>

European Territorial Management Information Infrastructure - ETeMII
<http://www.ec-gis.org/etemii/>

European Umbrella Organisation for Geographic Information (EUROGI)
http://www.eurogi.org/welcome_new/welcome.html

France's SDI, Conseil National de l'Information Géographique,
<http://www.cnig.fr>

Germany's SDI, Deutscher Dachverband für Geoinformation (DDGI)

The Global Change SysTem for Analysis, Research, and Training (START)
http://www.start.org/About/about_start.html

Global Map <http://www.iscgm.org/iscgm.html>

Greece's SDI development
<http://www.spatial.maine.edu/~onsrud/gsdi/Greece.html>

Human Frontiers Science Program

Human Genome Project

Hungary's SDI, Hungarian Association for Geographic Information (HUNAGI)
<http://www.spatial.maine.edu/~onsrud/gsdi/Hungary.html>

Incorporated Research Institutions for Seismology (IRIS) www.iris.edu

India's SDI development
<http://www.spatial.maine.edu/~onsrud/gsdi/India.html>

Indonesian National Spatial Data Infrastructure can be accessed through Badan Koordinasi Survei dan Pemetaan Nasional's (National Coordination Agency for Surveys and Mapping) site at <http://www.bakosurtanal.go.id/>

Intelligent Manufacturing Systems

Intergovernmental Panel on Climate Change (IPCC) <http://www.unep.ch/ipcc/>

International Civil Aviation Organization (ICAO) <http://www.icao.int/>

International Council for Science (ICSU) <http://www.icsu.org/>

International Geosphere-Biosphere Programme (IGBP) <http://www.igbp.kva.se/>

International Institute for Applied Systems Analysis (IIASA)
<http://www.iiasa.ac.at/>

International Organization for Standardization(ISO) <http://www.iso.ch/>

International Telecommunication Union (ITU)
<http://www.itu.int/home/index.html>

ISO/TC 211 Geographic information/Geomatics
<http://www.statkart.no/isotc211/>

Japan's Geographical Survey Institute and Japan's national spatial data infrastructure, <http://www.gsi.go.jp/ENGLISH/>

**Kiribati SDI development see
<http://www.spatial.maine.edu/~onsrud/gsdi/Kiribati.html>**

**Mongolia SDI development
http://www.spatial.maine.edu/~onsrud/GSDI_surveys/98_updates/mongolia.htm**

**National Geographic Information Infrastructure of Finland
<http://www.nls.fi/ptk/infrastructure/index.html>**

**Nepal's SDI development
http://www.spatial.maine.edu/~onsrud/GSDI_surveys/nepal/nepal.htm**

Netherlands SDI: National Geographic Information Infrastructure (NGII), see Ravi, The Netherlands council for GI: <Http://www.euronet.nl/users/Ravi> and the National Clearinghouse for Geographic Information (NCGI): <Http://www.ncgi.nl>

**Northern Ireland Geographic Information System
http://www.spatial.maine.edu/~onsrud/gsdi/Northern_Ireland.html**

**Pakistan SDI development
<http://www.spatial.maine.edu/~onsrud/gsdi/Pakistan.html>**

**Permanent Committee on GIS Infrastructure for Asia & the Pacific - PCGIAP
<http://www.permcom.apgis.gov.au/>**

**Permanent Committee on SDI for the Americas (PC IDEA)
<http://www.cpidea.org.co/cpingles/Publicar/index.html>**

**Poland SDI development
<http://www.spatial.maine.edu/~onsrud/gsdi/Poland.html>**

**Portugal's SDI, Sistema Nacional de Informação Geográfica (SNIG),
http://snig.cnig.pt/English/index_e.html**

**Republic of Korea's SDI development
<http://www.spatial.maine.edu/~onsrud/gsdi/SouthKorea.htm>**

**The Republic of Trinidad and Tobago SDI development
http://www.spatial.maine.edu/~onsrud/GSDI_surveys/trinidad%20&%20tobago/trinidad_survey.htm**

Russian Federation SDI development, see Russian Federation State Land Committee at <http://www.fccland.ru/>

South Africa SDI: National Spatial Information Framework, Department of Land Affairs, see <http://www.spatial.maine.edu/~onsrud/gsdi/Southafrica.html>

Southern African Development Community's (SADC) Environmental Information Systems Technical Unit (SETU)

Sweden SDI development is led by the National Land Survey of Sweden, see
<http://www.lantmateriet.se/>

UNEP Global Resource Information Database (GRID) see
<http://www.unep.org/>

United Kingdom's Association for Geographic Information see
<http://www.agi.org.uk>

United Nations Regional Cartographic Conference for Asia and the Pacific
(UNRCC-AP)

United Nations Regional Cartographic Conference for the Americas (UNRCC-
Americas)

United States National Spatial Data Infrastructure (NSDI)
<http://www.fgdc.gov/nsdi/nsdi.html>

World Meteorological Organization (WMO) <http://www.wmo.ch/index.html>

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